Consulting Engineer

December 1959

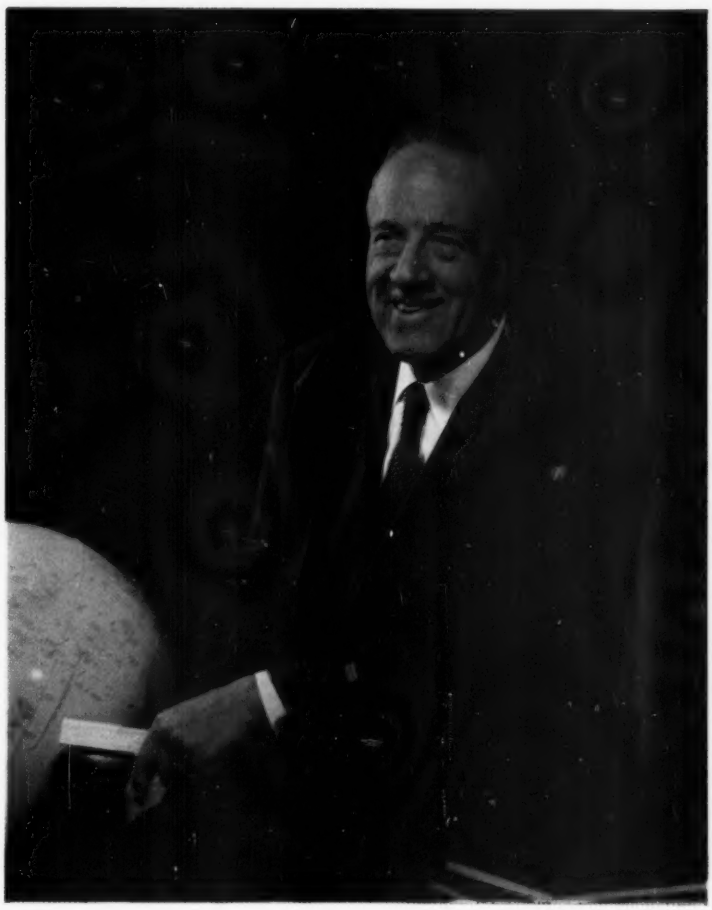


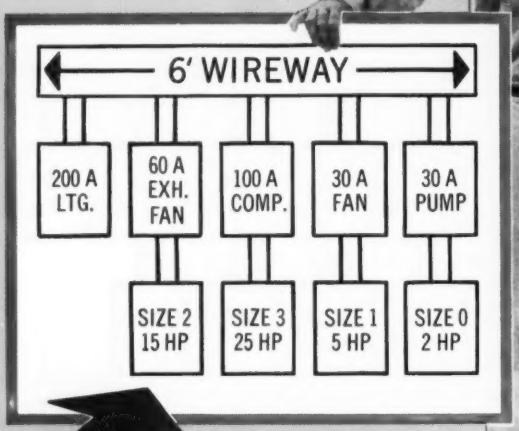
Photo by Fabian Bachrach

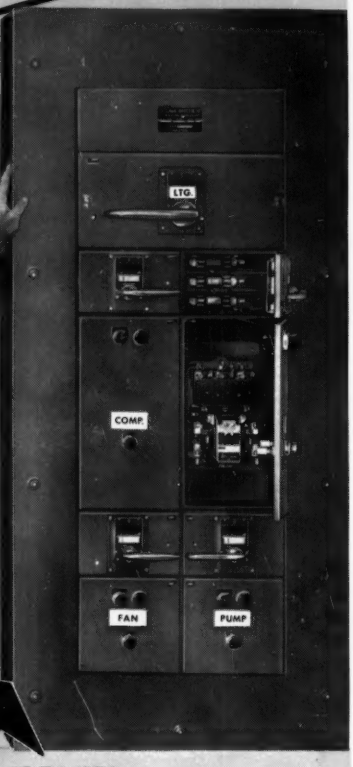
ALFRED L. JAROS JR., a senior partner of Jaros, Baum & Bolles and a former president of the New York Association of Consulting Engineers, has not allowed his firm's growth from a two-man outfit to one of the largest mechanical and electrical consulting firms in the nation to change him from an engineer into a businessman. His duties have included design, specification writing, and other engineering work, but one of Jaros' favorite activities is trying to stay technologically

Continued on Page 11

STARTERS IN QMB PANELBOARDS!

ANOTHER SQUARE D FIRST!





IT TAKES
41 HOURS AND 6 FEET
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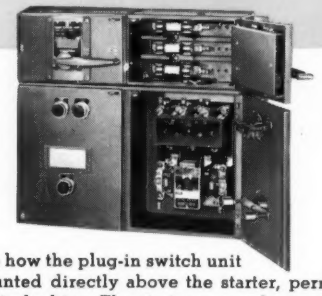
IT TAKES
12 HOURS AND 30 INCHES
OF WALL SPACE FOR THE SAME INSTALLATION WITH A QMB STARTER PANELBOARD

Why mount separate starters and disconnect switches? It costs extra money. It wastes space. It takes a lot more time. QMB Starter Panelboards give you a *safer* installation because you can't open a starter when the switch is ON. They give you a much *better looking* job. Since they can even be *flush* mounted, they offer a lot more installation *flexibility*. QMB panelboards accommodate reversing and non-reversing starters, sizes 0 through 3. QMB switchboards and unit substations handle sizes 0 through 5. All of them are available, factory-assembled and wired. Or get enclosures, starters and plug-in switch units from your Square D distributor for on-the-job assembly.

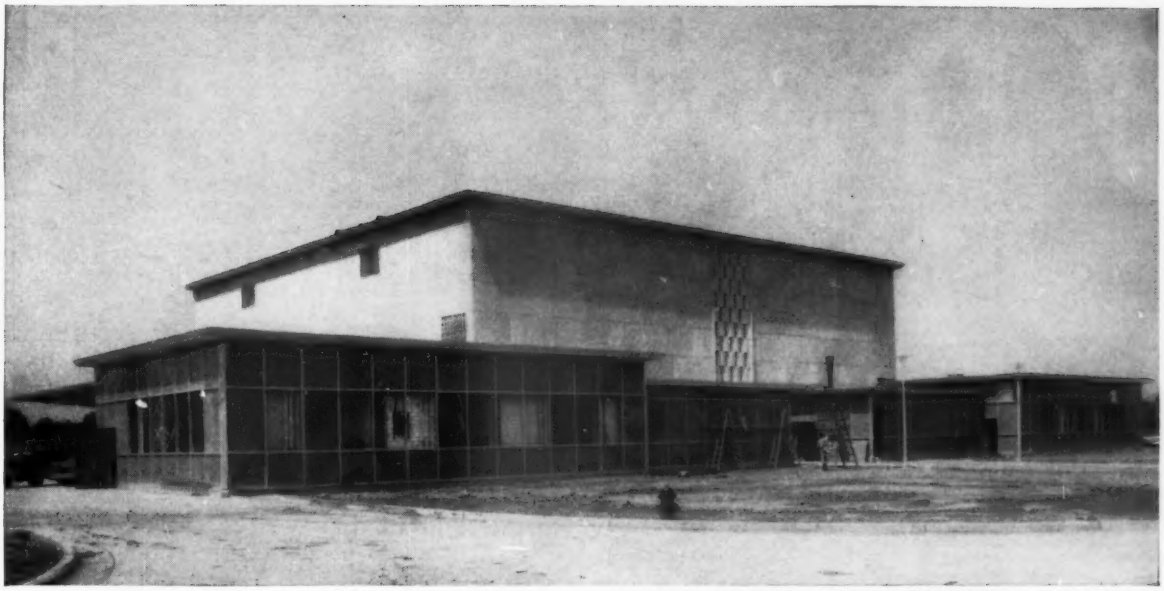


Notice how the plug-in switch unit is mounted directly above the starter, permitting interlocking. The starter cannot be opened when the switch is in the "ON" position.

It's easy to order these starter and switch units. See Page 57 in your Square D Digest and order from your distributor.

EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE

SQUARE D COMPANY



Architect: Voorhees, Walker, Smith, Smith & Haines
Contractor: Frank Briscoe

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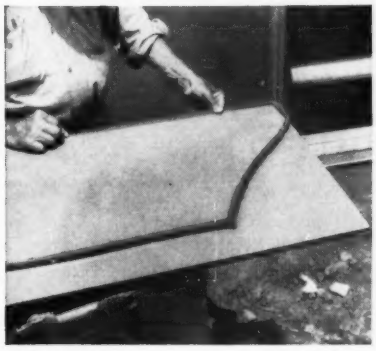
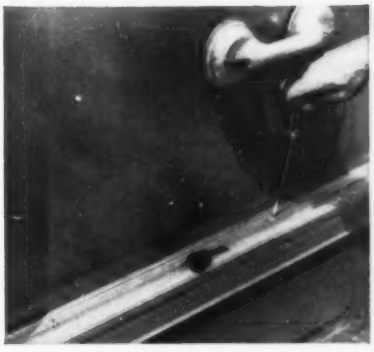
solves weather problem and seals for sure!



Easily installed — Butyl preformed gaskets can be installed on-site or in the shop. They protect panel edges during handling.

Faster glazing — installation of lights is done quickly and more efficiently when edges are protected by Butyl preformed gaskets.



All-around weather protection — the superior resistance of Butyl to ozone, sunlight, heat and moisture provides a sure seal.

Modern mullion, sill and transom design requires highly efficient sections that insure a reliable sealing job. Low-cost Enjay Butyl rubber enables the design of trim, neat window details – provides a permanent weather-tight seal. In this application Butyl does a better job than conventional rubbers because Butyl gives superior resistance to ozone, sunlight, heat and moisture. This means Butyl resists cracking, crazing and loss of elastic properties.

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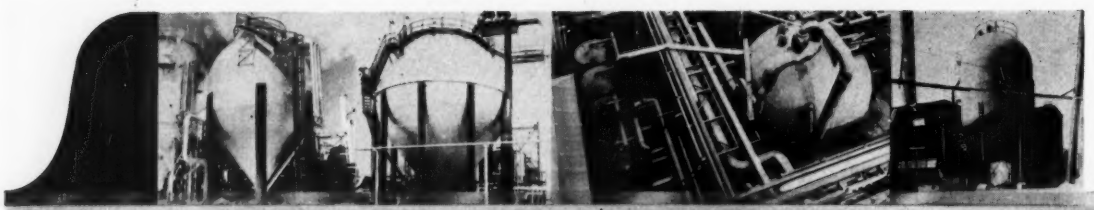
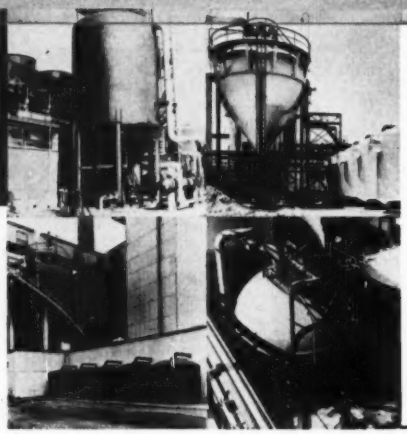


Designed to Handle—



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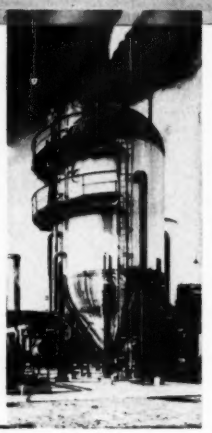

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No matter what the service condition—variable flow rates, changing raw water composition, high turbidity, high silica, or any combination of the above, Graver Hot Process-Hot Zeolite Systems are designed to consistently produce the required quality effluent. This means *lowest* turbidity, silica, alkalinity and hardness.

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Designed to meet the needs of today's processing industries requiring makeup treatment to medium pressure boilers, Graver Hot Process-Hot Zeolite Systems assure uninterrupted operation with the best possible treatment results under all feed conditions.

WRITE FOR DESCRIPTIVE LITERATURE

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For Engineers in Private Practice

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December 1959 • VOLUME XIII • NUMBER VI

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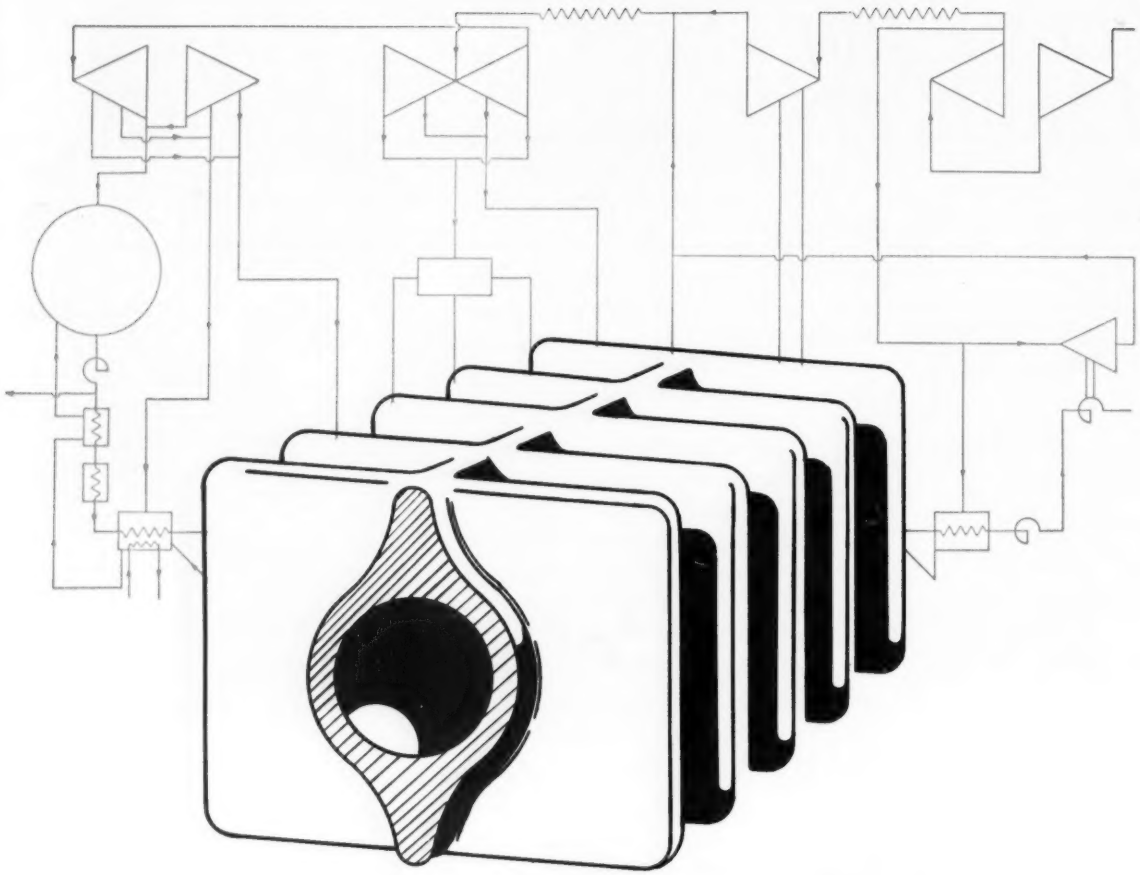

Green's Low-Level Economizer belongs on your steam cycle flow diagram!

Why has Green's Low-Level Economizer already been purchased for inclusion in several large units scheduled for operation in 1960, 1961 and 1962?

1. It is accepted that low-level heat recovery offers the most economic method of obtaining the lower heat rates required today.

2. Flue gas-to-water heat exchange transfers the low temperatures from the airheater to the Low-Level Economizer where the problems of corrosion and plugging can be adequately resolved.

Green has had over 100 years of economizer experience. It is yours for the asking.

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BEACON 3, NEW YORK

your responsibility, too!

this or this

Good fire protection starts on the drawing board. National statistics show that the wrong kind of protection--or not enough of the right kind--has burned hundreds of plants to the ground.

ALL BIG FIRES START SMALL

Usually they start in "Hot Spots"—efficient but hazardous operations where small, sudden fires can reach disaster size almost instantly. Typical are such hazards as quench and dip tanks—spray booths, rooms and tunnels—oil cellars—transformers and their vaults—generators—any place where processing, storage or handling of flammable liquids takes place. In your plans, there may be many others of equal danger.

For such hazards a man and a hand extinguisher are not enough—may be worse than no protection at all. Nor is an "overall" protection system the answer.

"Hot Spot" hazards demand specialized protection. By providing it you can help keep your client company in business and making profits. We'll be glad to help you evaluate these "Hot Spots"—built and building. Write and we'll arrange a meeting with a Cardox Fire Protection Engineer.

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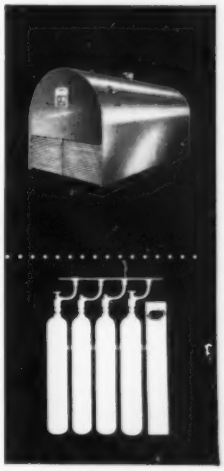
LOW PRESSURE SYSTEMS

Highest form of engineered protection for critical special hazards. The systems that made carbon dioxide *No. 1 protection* for so many of industry's toughest hazards. Originated, pioneered and perfected by Cardox. Thousands of pounds-per-minute application of carbon dioxide if needed. Centralized storage of any quantity of carbon dioxide—lbs. to tons—any number of hazards, indoors or out.



NEW HIGH PRESSURE SYSTEMS

The first *performance-engineered* high pressure systems for smaller capacity needs or physical conditions where cylinder-type systems offer advantages. Exclusive constantly energized, continuously monitored control system. Total flooding and local application by any means of application. GET THE FACTS!

AMERICA IS MOVING UP!

With commercial power demands increasing rapidly and steadily

Power Distribution Systems

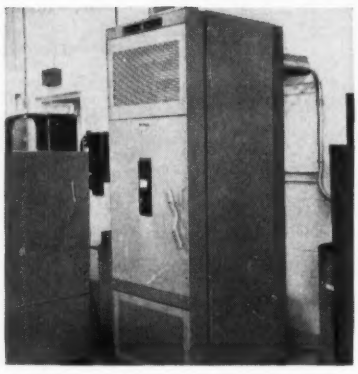
A DRAMATIC DECADE of construction and modernization of commercial buildings lies ahead. Buildings designed to newer and higher standards of utility and beauty—and to meet more exacting requirements of comfort and service for occupants—must be served by electric power distribution systems with capacity to handle tomorrow's heavy loads efficiently, reliably, and economically.

POWER DEMANDS IN COMMERCIAL BUILDINGS are increasing even more rapidly than in factories. During the next ten years, the steady trend towards higher levels of illumination, plus increased use of air conditioning and electric business machines, will probably raise typical load from today's 12 volt-amperes per square foot to 18 or more volt-amperes per square foot. Indeed, this level has already been achieved in some buildings!

FORESTALL EARLY OBSOLESCENCE of your power distribution system by using the products, equipment, and higher voltage systems specifications that General Electric has developed in support of consulting engineers and contractors. For more information, contact your nearest General Electric Apparatus Sales office or write General Electric Co., Section 680–19, Schenectady 5, N. Y.

GENERAL ELECTRIC

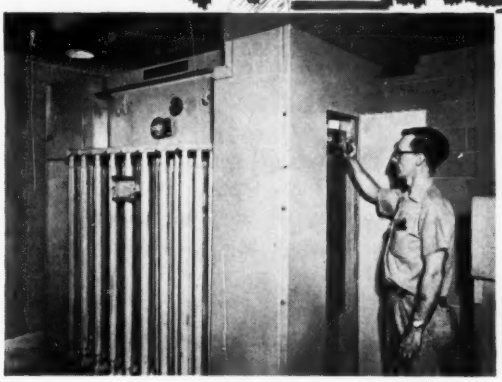
CAPACITY to handle larger lighting and air conditioning loads begins with selection of the combination 480Y/277 voltage (identical to 265/406Y). Today, lighting levels of 100 foot-candles are not uncommon. 200 foot-candle levels are a probability for tomorrow.



SAFETY is paramount in system planning. Damages resulting from equipment failure may exceed value of the system itself. This LB-1 Power Protector for service entrances safeguards equipment and personnel by providing complete "switchability" under all load conditions.

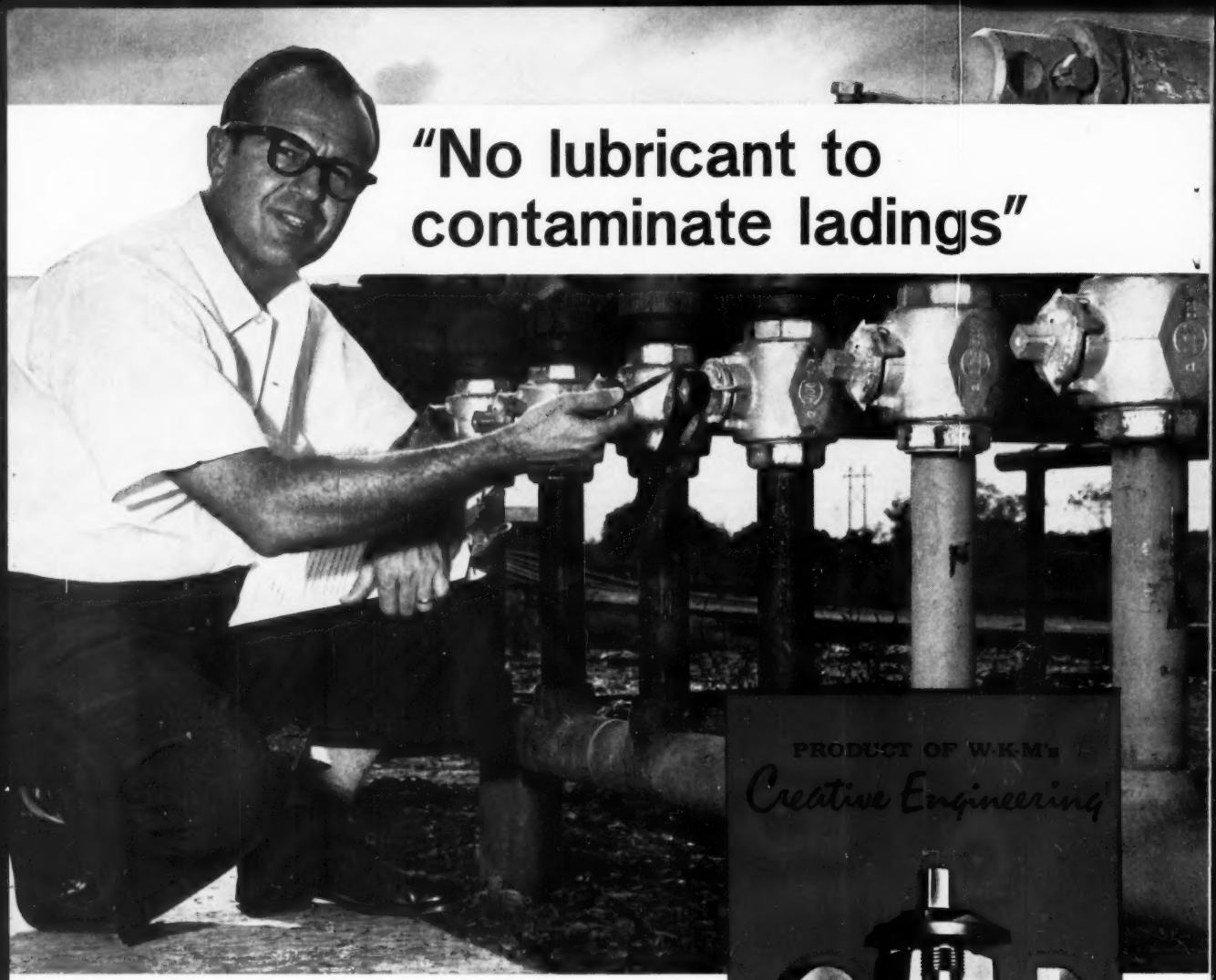
ECONOMY is also realized by the combination voltage which cuts down on the size and number of cables and busway services. Flexible plug-in busways (above) add savings because of their adaptability. All told, savings as high as $20 per kva may be realized.

must move up, too



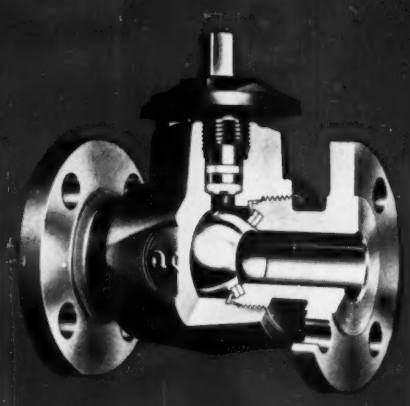
PLANNING a combination voltage system is simplified by the fact that the higher voltage is available to commercial buildings either from the utility's 480Y/277 volt network transformers or from your own Integral Distribution Center or Load Center Unit Substation.

RELIABILITY depends on adequate modern equipment. Load Center Unit Substations with AK-2 power circuit breakers can be selectively coordinated. This assures continuous power by preventing faults or overloads from threatening service in the entire system.



"No lubricant to contaminate ladings"

PRODUCT OF W-K-M's *Creative Engineering*



acf® non-lubricated Ball Valves

ACF Ball Valves are specially designed for ladings that require absolute purity. There is no lubricant, no possibility of contamination. The chrome-plated ball is suspended between Teflon seats under compression for leakproof sealing.

A quick quarter-turn operates this rugged valve. Specify it. You'll get efficient, economical performance. *Available at leading supply stores everywhere.*

Service-proved for 4½ years with such ladings as: high octane gasolines • alkalis • caustics • liquefied petroleum gases • butane • propane • synthetic fuels • penetrating gases • alcohol.

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Working Pressures: In carbon steel with ASA ratings of 150 and 300, and a few sizes in ASA 600; in semi-steel with 200 and 400 pound ratings.

Sizes: ½" through 6".

5911-R

Alfred L. Jaros Jr.

– Starts on front cover

one step ahead. He has succeeded to the extent that Jaros, Baum & Bolles has gathered an enviable list of engineering "firsts."

Jaros, Baum & Bolles was consulting engineer for the first entirely air conditioned large building in New York City and also designed the first radiant cooling project in the United States. Currently the firm is working on one of the largest skyscraper air conditioning projects in history – the Grand Central City office building, in New York City. The firm is also handling the mechanical and electrical design for the United Engineering Trustees headquarters across the street from the United Nations Building.

Native New Yorker

Though he has handled projects in all parts of the world (and is on his way to Morocco as this is written), Jaros always has had his home in or close by New York City. Born on the site of the Tammany Hall building, Jaros was the son of an American agent of a French chemical house. His father was self-educated, and insisted that the son be exposed early to languages, good books, and music.

One of the best friends of Jaros Sr. was a real estate man, who used to take young Jaros for Sunday morning walks in Central Park. At that time, the two had many talks about professions the boy might follow. "Guided, no doubt, by my relator's ideas, I thought I wanted to be an architect, but I developed an intense interest in science and mathematics in high school and decided to become a mechanical engineer instead."

With a good high school education at the Ethical Culture High School (now called Fieldston School) behind him, Jaros entered engineering school at Columbia University, working in the summers (without pay) as a draftsman for an uncle who owned Traitel Marble Company, the firm that handled the interior stone work for Pennsylvania Station and for the Metropolitan Museum.

When graduated, in 1911, Jaros and one of his classmates, Albert L. Baum, went to work for a well known consulting firm, Nygren, Tenney & Ohmes. This firm was the successor of Alfred R. Wolff, one of the first consulting engineers to specialize in mechanical engineering for buildings.

From this firm, Jaros got both experience and a creed he still uses. "Wolff always insisted on giving his clients 'nothing but the best' engineering. He would turn down a job if a client insisted on something less than the right approach."

It is good that Jaros was getting experience, because the pay rate for draftsmen in those days was hardly lucrative. "They would begin engineering school graduates at $12 a week – $15 was unusually high." At the end of the first year, Jaros was given an increase to $18 a week. "They paid us our regular hourly rate for overtime though, plus supper money – an hour's wages or the price of a good meal, whichever was highest, but seldom more than a dollar." With this background, it is understandable that Jaros, when he set up his own business, insisted on overtime and meal payments long before this was common practice.

"In those days, I lived at home and paid $5 a week board from my $15. By the time I bought my 20¢ lunches and paid for my subway fare, I was nearly broke at the end of the week. We really had no right to complain, for at that time a medical intern was paid nothing."

One of Jaros' early assignments was tracing drawings for the Woolworth Building. The first project on which he drew the plans and supervised construction was late in 1912, the Brearly School for Girls, in New York City. The school has long since moved to new quarters, and the building has been demolished.

During his five years as an employee, his most interesting job was the Letchworth Village for the Feeble Minded, near Haverstraw, N. Y. This was one of the earliest mental institutions to be laid out on a cottage system. A central heating plant was built, and water was piped about a mile to the furthermost buildings – which also were about 200 feet higher than the central plant. This presented some interesting problems for a young mechanical engineer.

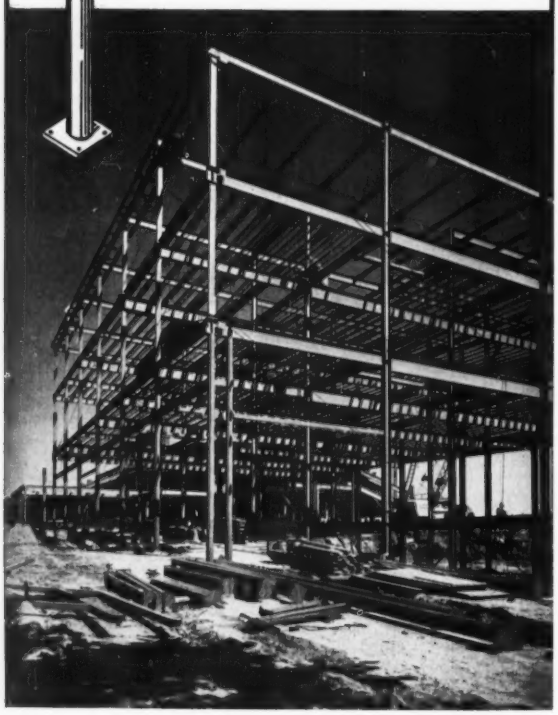
Forms Partnership

In late 1915, Jaros and Baum decided to go into business for themselves. This was during a mild depression, but with their low salaries, the two figured they did not stand to lose much. "We were young, inexperienced, and had a lot of nerve," Jaros recalled. His uncle gave the two a free corner of the marble works for their drafting boards. The partners got several small jobs, and made "a sort of a living."

At the beginning of World War I, the firm was discontinued when both partners joined the Navy. Both became engineering designers for the Bureau of Yards and Docks, gaining more experience and making contacts which were useful later.

In 1919, Jaros and Baum again went into business together and did well during the minor boom that followed. One of their first major clients was the Allerton Hotel chain, which built a series of small-room bachelor hotels in New York City.

The firm got the mechanical and electrical contract for the Shelton Hotel, tallest in the world



at that time. Soon it did the London Terrace, then the largest apartment house in the world, and also handled many of the early small air conditioning designs for theaters and restaurants.

Jaros, in his capacity as company "reader" keeping up with technical developments, read of an English engineer who was designing radiant heating systems. Jaros invited the English engineer to spend several weeks in New York. Soon after, the firm was asked to design a radiant heating system for the British Embassy, in Washington. "As far as I know, this radiant heating system still is in use," Jaros added. Jaros & Baum continued to study radiant heating, and designed many other early installations such as the "Port of Missing Men," a large hunting lodge built by a wealthy oilman, Col. Henry Huddleston Rogers.

Firm Expands

The firm grew steadily until the early 1930s, and the depression. "It hit us like it did everyone else. We decreased the staff, cut salaries, and took no money out of the business for ourselves. But in 1932, Baum and I joined forces with Frederick N. Bolles, who specialized in plumbing and water supply. We then could offer a more complete engineering service, and his contacts helped."

Business improved. Tiffany became the first company in New York City to want an entire building air conditioned, and Jaros, Baum & Bolles got the job. "An air conditioning project in those days was truly a custom job. We had a selection of fans, pumps, motors, and coils but more of the details had to be designed to order than today. For instance, the outlets were built to our own designs."

Another pioneering step was taken by Jaros, Baum & Bolles when they designed what Jaros thinks is the first hospital installation in the country of a million-volt X-ray machine – at the Memorial Hospital for Cancer, in New York City. (The majority of X-ray installations in those days were 50,000 volts.) The X-ray machinery was so well designed that no additional shielding was needed.

Shortly before the beginning of World War II, Jaros, Baum & Bolles got a project that was to keep the firm busy during most of the war years. The Navy employed the firm to design the mechanical work for a base in the Panama Canal Zone. The project included a bombproof power plant, air conditioned warehouses, hospitals, and barracks. "We were tight on time, and much of the work was highly classified," Jaros explained.

From this venture, Jaros learned a lesson. The firm now accepts no foreign projects that cannot be handled from the New York office with regular visits for inspection. "Field offices take key men away from their regular jobs for too long. You

LATEST IN COOLING Gas operated York machines feature the use of tap water as refrigerant and lithium bromide as absorbent, one of the most efficient, practical refrigeration cycles developed so far. Machines start and stop automatically.

"with **YORK GAS** *air conditioning our boilers keep us cool all summer"*

"With our boilers sized for a winter load, we were naturally oversized for the summer months. But York's gas-operated Lithium Bromide absorption water chillers permit us to make efficient use of part of this steam capacity to cool," says Mr. M. J. Mather, President of the Allen Manufacturing Company, makers of hex-socket screws.

The York Lithium Bromide system eliminates the need for huge compressors found in other types of cooling equipment . . . which brings down the original cost considerably. And with gas as the boiler fuel, you make year-round use of an otherwise wasted source of power *at rock bottom costs.* In addition, York machines are noiseless, lightweight, compact – easy to install and readily adaptable to almost any plant layout.

Find out how your present heating system can pay off for you all year 'round with gas-operated York automatic water chilling units. Call your local gas company or write to the York Corporation, Subsidiary of Borg-Warner Corporation, York, Pennsylvania. *American Gas Association.*

either send them or staff foreign work with men whose ability you cannot guarantee but for whose mistakes you are responsible. Your regular clients are alienated because you are not available when needed. Repeat projects are lost, and these are the backbone of our work."

The end of World War II did not mean the end of Navy work for Jaros, Baum & Bolles. Several years ago the firm designed an aeronautical gas turbine laboratory valued at about $25 million. This included the design of chambers for air velocity up to the speed of sound, and for a temperature range from –70 F to 3000 F.

During recent years, the firm has handled the mechanical design on such well known jobs as the Seagram Building, Lever House, the Socony Mobil Building, the Mile-High Center, in Denver, and the Republic National Bank, in Dallas.

One of the firm's most interesting projects was the development of the radiant cooling system for the Alcoa Building, in Pittsburgh. Prior to the design work, the firm spent many months guiding researchers in Alcoa laboratories making extensive materials and performance tests. "We thought it could be done, but we needed extensive research data to be sure. By the time we began work, we had a complete set of design criteria," Jaros explained.

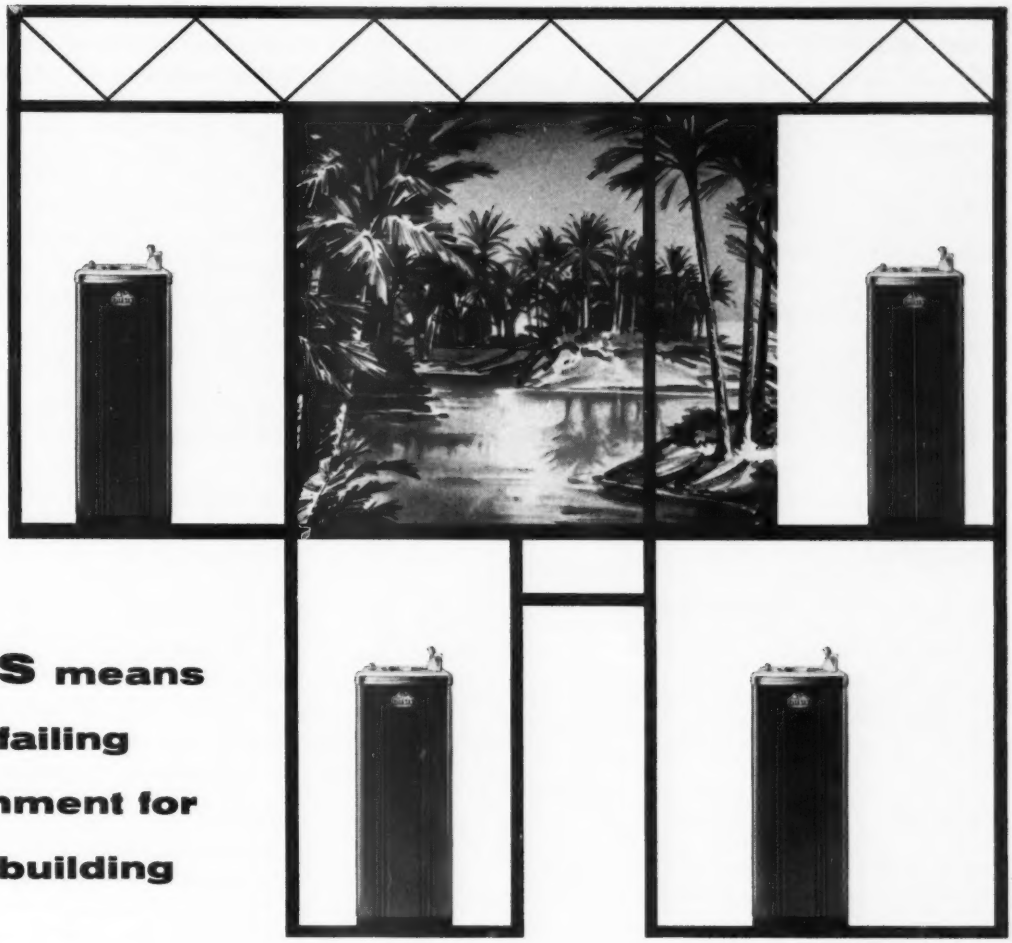
Another of the firm's current projects is the Chase-Manhattan Bank building. "Pumping water up 60 stories would have presented quite a problem, so we put refrigeration equipment on the 11th and 31st floors. Essentially, we have two refrigeration plants and one of the largest air conditioning projects in the world," Jaros pointed out.

How does Jaros manage to keep so well versed on technical developments in such a rapidly expanding field? "I am an avid reader, have a good memory, and pay attention to what I read," he says, and he thinks that with the wealth of material available, it is important to develop the habit of "skimming." He finds something valuable in about one out of 20 articles he reads.

Professional Organizations

Jaros has been so busy with his own engineering career that he has not found the time to be overly active in professional organizations. He was president of the New York Association of Consulting Engineers, "and I think the Consulting Engineers Council is a fine thing for the profession." He also is a member of ASME, AAAS, SME, NSPE, and NYSSPE, "but I am not a very active member of any of them."

However, he enjoys public speaking and has served on a number of American Society of Heating, Refrigerating, and Air-Conditioning Engineers panels. He also has spoken on a number of occa-



OASIS means never-failing refreshment for every building

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sions to the American Institute of Architects, to the Building Research Institute, and to the Building Owners' and Managers' Association.

"I like to talk to architects," Jaros says, "I tell them to engage an engineer at the very start of the project. Tell him everything about the program and the owner's desires. Make him fit his ideas into this program – but give careful consideration to his every suggestion. And give the engineers time enough to do a thorough job. Good engineering, especially in an unusual building, requires lots of comparative studies and computations, and nothing is more detrimental than so tight a schedule (or so many major changes late in the schedule) that the engineer must concentrate only on getting through."

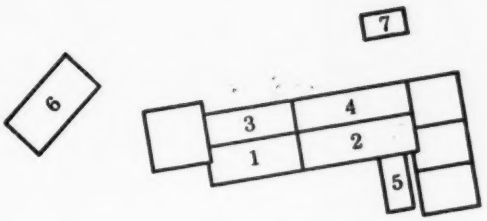
Jaros, whose firm works mostly with architects, notes that the larger architectural firms do not give all of their work to any one consulting engineer. "They think this keeps the consulting engineers on their toes. Who knows, perhaps it does. At least this means that the engineer does not get stale working on only one type building. And he does not become so tied up with one architect that he loses his other clients."

In a recent speech, Jaros advised engineers to: "Understand just what sort of project is wanted, and use your ability and imagination to create what will best fit that program. There are many schemes and techniques available to you. Do not copy from some other and different job, but take the time to develop what will best serve this one. And do not be afraid to argue with your clients for what you know is right. You are an engineer, not a draftsman. And you are being paid to apply your judgment, your experience, and your originality – not just to turn out drawings."

Jaros said that engineering has its share of incompetents. "Unfortunately, some of them have cut quite a swath." He would like to see better policing of the profession, perhaps by the CEC.

"I also would like to see an end to engineers engaging in price competition with each other. An engineer should take a fee or leave it. I do not know how this competition ever can be eliminated completely, but I would like to see a real effort made."

Today, Jaros, Baum & Bolles has five partners. C. E. Smith, who once handled most of the electrical work for the firm, joined it in 1957, and Richard T. Baum was named a partner last year. There are more than 130 employees, and the firm occupies most of one floor of a new skyscraper. "I still get a little nervous when I see the size of the payroll," Jaros said. Yet he considers himself lucky to be a consultant who has been able to devote his time to engineering. "I have partners who are good businessmen as well as engineers, and I leave the business end to them." ▲▲



The Wheaton Plaza Regional Shopping Center, Wheaton, Maryland
Arthur L. Anderson, Architect. Lathrop Douglass, Consulting Architect
J. Gibson Wilson, Jr., and Beall & LeMay, Consulting Engineers

7 out of 11 constructed with USS AmBridge Steel Joists

Convincing examples of the trend towards steel joist construction are the new shopping centers springing up throughout the country. For example, 985 tons of USS AmBridge Steel Joists were used in 7 of the 11 buildings in the vast Wheaton Plaza Regional Shopping Center now being completed at Wheaton, Maryland.

USS AmBridge Steel Joists provide rigid, economical and light-weight construction suitable for most types of roofs, ceilings and floors. Their ease and speed of erection cuts installation time, helps get the structure under cover sooner, and makes schedules easier to meet. And when steel joists have been erected and properly bridged, they immediately form a safe working platform for other trades.

When you specify USS AmBridge Steel Joists you are sure of getting the finest open-web steel joists available anywhere. AmBridge Joists are quality controlled through every step of the manufacturing process—from furnaces through fabrication. They are consistently uniform and completely reliable. For detailed information, contact our nearest Contracting Office.

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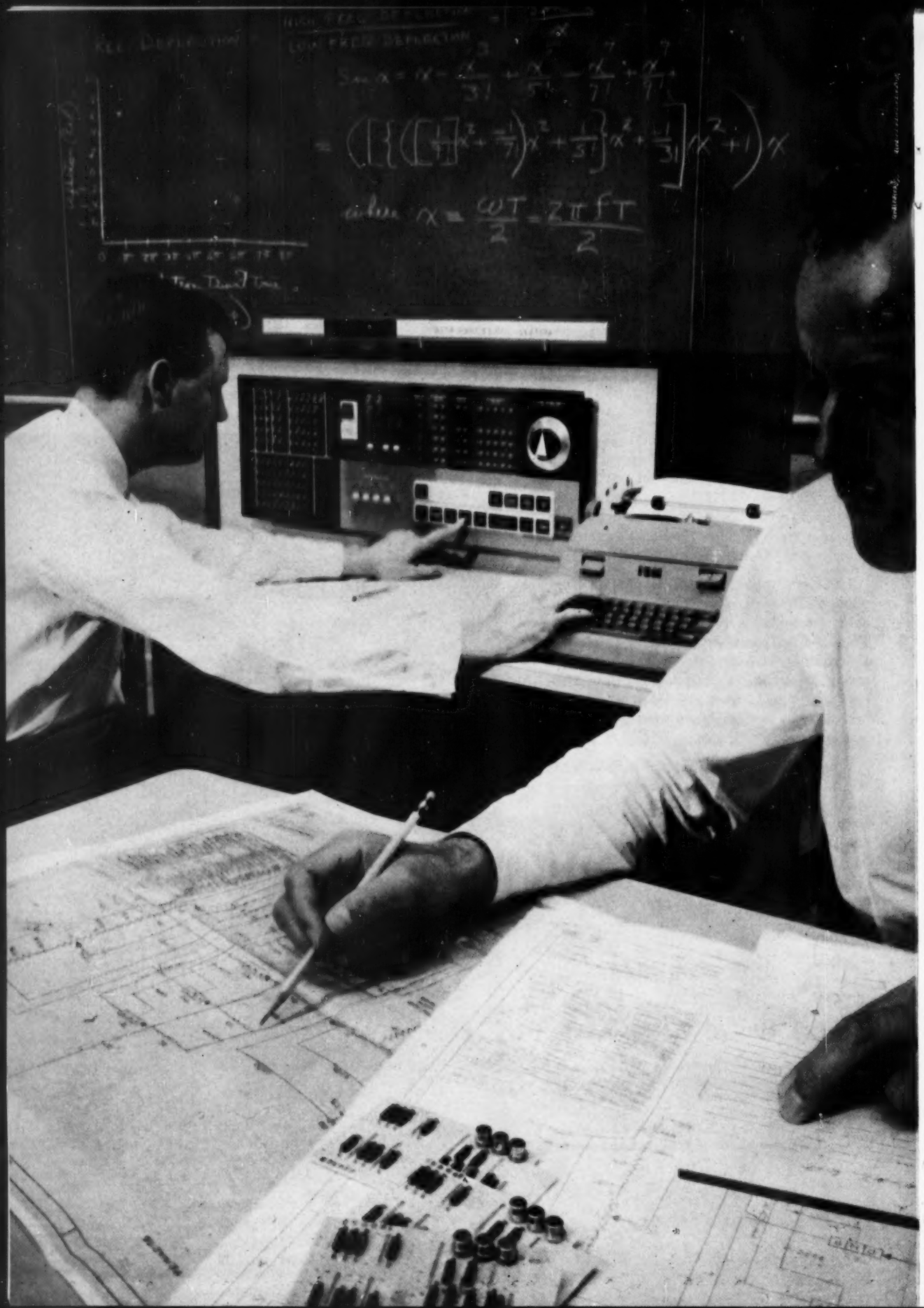

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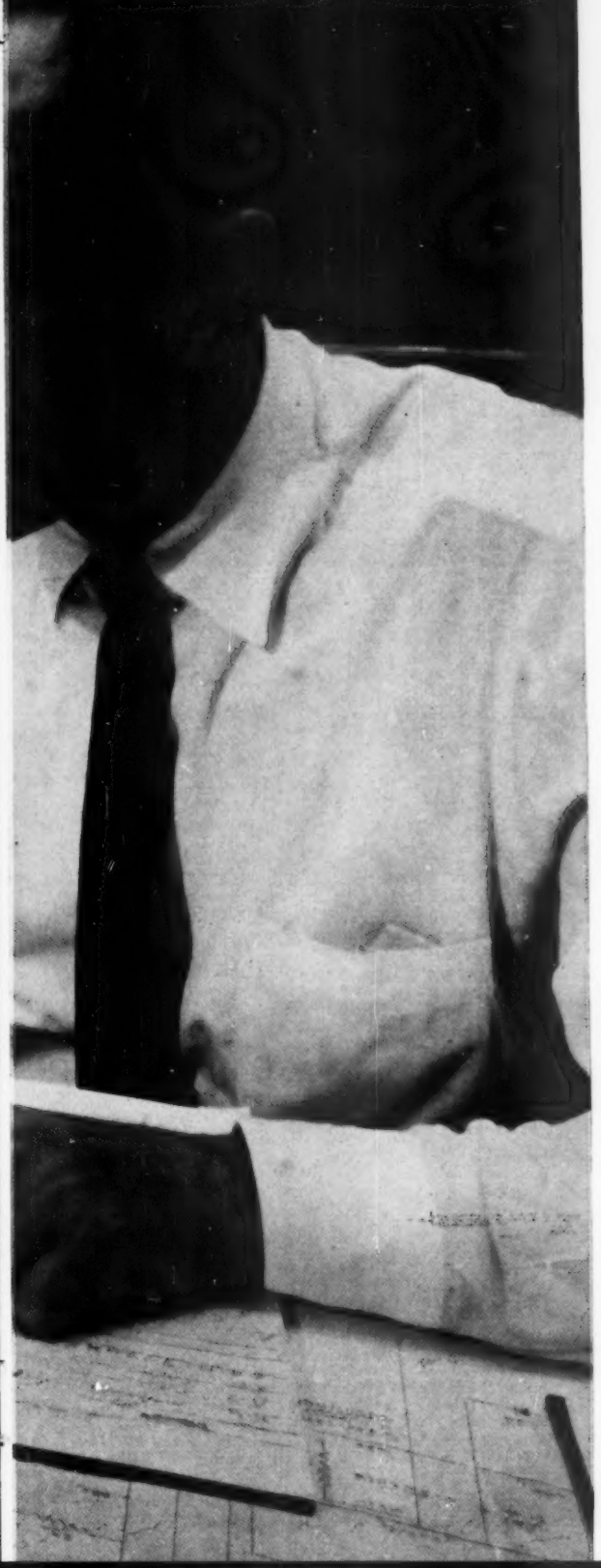

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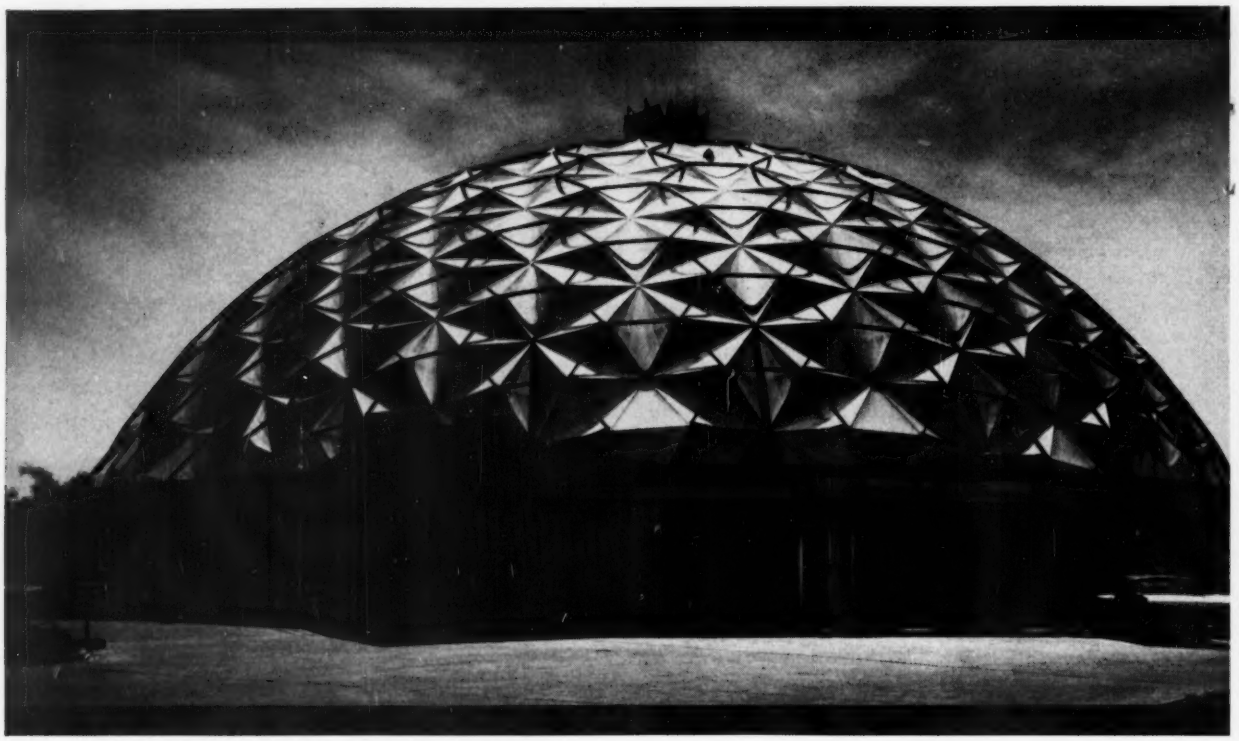

Citizens State Bank, Oklahoma City, Oklahoma. Three Ceco products were used to help achieve a dramatic architectural effect here. The products were Reinforcing Steel, Wire Mesh and Open-Web Steel Joists. Architect: Bailey-Bozalis-Dickson and Roloff; Contractor: Secor Building Company, Incorporated.

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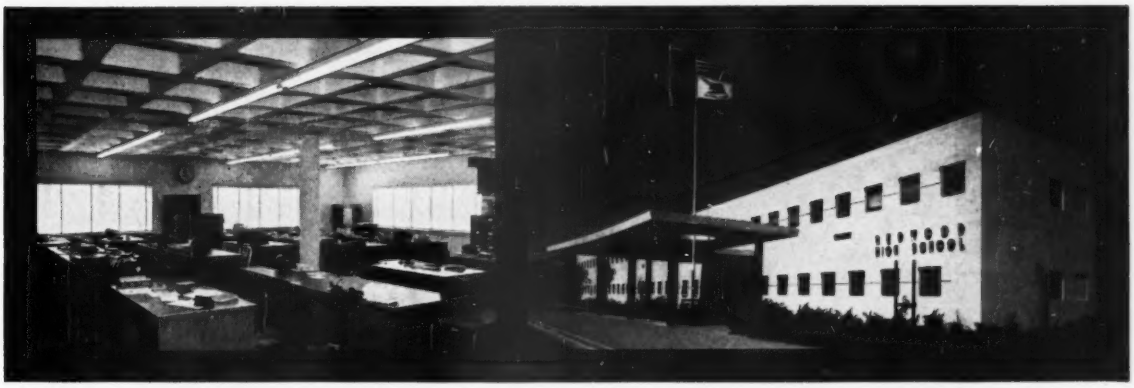
Bank of Commerce, Washington, D.C. This is an example of concrete joist construction through use of Ceco Steelforms. Concrete was reinforced with Ceco Rebars. Ceco 200-B Aluminum Double-Hung Windows provide adequate daylighting and weathertight protection. Architect: Corning & Moore; Contractor: Standard Construction Company, Inc.



Ellis Truck Terminal, Indianapolis. Exposed waffle ceiling created with Steeldomes. Other Ceco products: Aluminum and Steel Windows, Hollow-Metal Doors, Steel Joists, Steel Roof Deck, Reinforcing Steel and Welded Wire Fabric. Architect: Monical & Wolverton; Contractor: Bugher Construction Co.

Redwood High School, Larkspur-Corte Madera Area, Marin County, California. In this handsome school building the architectural needs were met by four Ceco products: Reinforcing Steel Bars, Open-Web Steel Joists, Cecor Centering and Ceco Metal Windows. Architect: Gromme, Mulvin & Priestley; Contractor: Midstate Construction Co.

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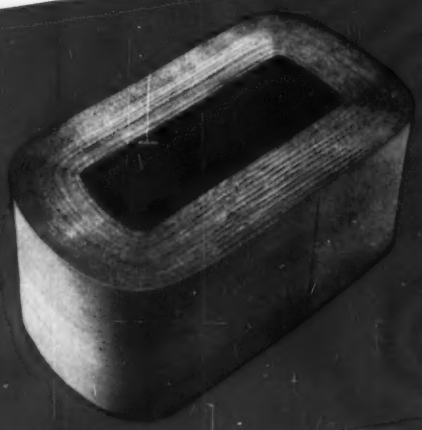

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The coils have lower impedance to provide a lower internal voltage drop at all loads. This means that during peak load periods Moloney's distribution transformers can carry higher overloads at the same permissible regulation.

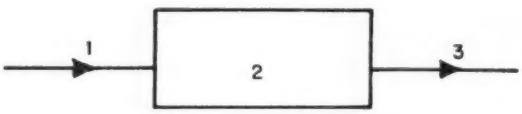
From the Editor's

Tranquil Tower

AT THE RECENT Consulting Engineers Council meeting in Cincinnati, some interesting preliminary efforts were made to establish a policy with regard to the fee an engineer should charge when he specifies packaged or standardized plants for a client. In sanitary engineering this could involve the specification of a package sewage treatment plant. In mechanical engineering it might mean a complete materials handling and storage system designed, manufactured, and assembled by one company. In electrical engineering it might be the specification of a package power plant or substation. And there have been, for many years, standardized buildings that structural engineers could specify in place of their own original designs.

Sometimes these standard units are just what the client should have. They meet all of his needs, and it would simply be a waste of money for the consulting engineer to insist upon a custom built job when the owner would gain nothing but a higher construction invoice. Under these conditions, the engineer is doing an honest job for his client only when he specifies the package plant or the standardized system.

If the plant is, we will assume, a sewage treatment plant for a small town, the consulting engineer might prepare a drawing that looked like this:



Notation (1) is a fully and properly described sewage line leading into the plant, (2) is a packaged Jones & Jones sewage treatment plant, Catalog No. 17360D, and (3) is a fully and properly described effluent outfall. If this were the extent of the engineer's design effort, what kind of a fee would he deserve? It seems to some that the consulting engineer logically deserves something less than his full fee — and we assume throughout this discussion that the engineer is working on a fee based on percentage of construction cost. His drafting work is simplified, and his supervision responsibilities are lessened since the manufacturer must assume sole responsibility for the package. Also, the actual design work has been done by the manufacturer, though it is true that he is able to divide it among all the units of that model he sells.

Looking at it this way, the engineer who charges his client a full fee for specifying a packaged plant is charging for work he did not actually perform. This seems unfair to the client, and it was with this thought in mind that the CEC policy statement condemning, in effect, consultants who charge full fees under these conditions, was put before the board of directors (see "Field Notes," starting on page 136). The proposed policy statement failed to pass and was returned to the ethics committee for further consideration. This was the proper action, for there is a real problem involved, but a simple reduction of fees when specifying packaged equipment is not the answer.

There appear to be, in fact, many questions and few good answers. We might ask, for example, when a package stops being a part of the project and becomes the project itself. A turbine generator unit is centainly a major item, and it is supplied as a package by a manufacturer. Yet, no one would suggest that it is, in itself, so much of the power plant that the consulting engineer should reduce his fee because some great manufacturing company and not the engineer's own firm did the turbogenerator design.

On the other hand, a mobile power plant, designed and built by one manufacturer, is quite obviously a complete project, and the engineer who recommended that his client purchase this unit might have difficulty justifying a fee equal to that he would have charged had he done all the design work for the plant and supervised its construction. He might find it particularly difficult to ex-

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plain his fee if it had been based on a "highly technical" schedule, as power plants normally are.

The policy statement offered the board of directors of CEC hoped to solve the whole matter by stating that less than a full fee should be charged if the package is a *major* part of the project. This is thoroughly unsatisfactory, however, for it fails to define *major*. The turbogenerator certainly is major, many materials handling systems are major, yet the specification of either of these does not call for a reduced fee. Some better definition must be found to draw the line between package plants and standardized items of equipment.

There are other strong points of view. Some claim that the enginer who specifies a package unit may, in most instances, deserve an even higher fee. One Council board member pointed out that in his own experience he had found that it took more of his and his top engineers' time to specify a package unit than to put a similar unit together from usually available parts of known reliability. The package, rather than simplifying the engineer's job, requires him to make a thorough design study of someone else's design, familiarizing himself with it in every detail and making sure that it will fulfill the client's needs. This may be more difficult than preparing an original design, and if it is, it certainly will deserve not only the full fee but more.

While this position may be a good one, particularly on a first of its type project, after the original investigation, it surely is simpler to specify the package than to design from scratch. The package itself becomes merely a familiar piece of reliable equipment and is specified as such.

This argument brings us full circle again. If the package plant truly is simply another piece of equipment, then full fee should be charged against its cost just as against the cost of lesser items. When a consulting engineer specifies switchgear for an industrial plant, the cost of the package switchgear becomes a part of the cost of the entire plant, and therefore the fee is charged on it. Yet, it was not many years ago that there was no package switchgear, and the consulting engineer designed his own, carefully specifying even the center-to-center distances between poles of switches. If the engineer today simply picks a number from a catalog to specify a switchgear unit, he still gets his full fee based on its cost. So it should be, many claim, even if the whole plant comes under a catalog number.

Perhaps the most damning criticism of the proposed policy statement takes off from an entirely different direction. This group of critics points out that no organization has any business directing engineers to lower their fees under any conditions. It is extremely dangerous ground, legally, to even publish recommended minimum fee schedules, and it is quite likely that these things have gotten by for doctors, lawyers, architects, and engineers only because it is generally understood that there is no open competition among true professionals.

Recommended minimum fee schedules have been accepted as not exactly being price fixing agreements — at least not in the worst sense. However, if the fact that these schedules are *recommended* minimums is overlooked in an official policy statement of a national organization, and members are told to charge less under certain circumstances, then the fee schedules lose their status as recommendations and appear to be serious attempts at price agreement.

Furthermore, the policy statement seems to forget not only the recommended but the *minimum* aspect of the fee schedules. Surely an engineer under any fee schedule has a right and is in fact encouraged to charge more than the minimum if he wishes. If he is required to charge less, that is price fixing, and it is quite likely illegal. We must not forget, however, that there is a real problem, even if we do not know the answer, and it is not proper for an engineer to charge a client for work he does not do. Some answer must be found, and this proposed policy statement was just the first attempt. The need for a proper answer grows daily as more and more packages are offered in more and more fields. ▲▲

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Vision length—5 port—12⅜" and 7 port—18". Longer vision lengths easily obtained by adding 18" or 12⅜" sections for necessary length.

MODEL MP-3000 MULTI-PORT
For boiler pressures up to 3000 psig.

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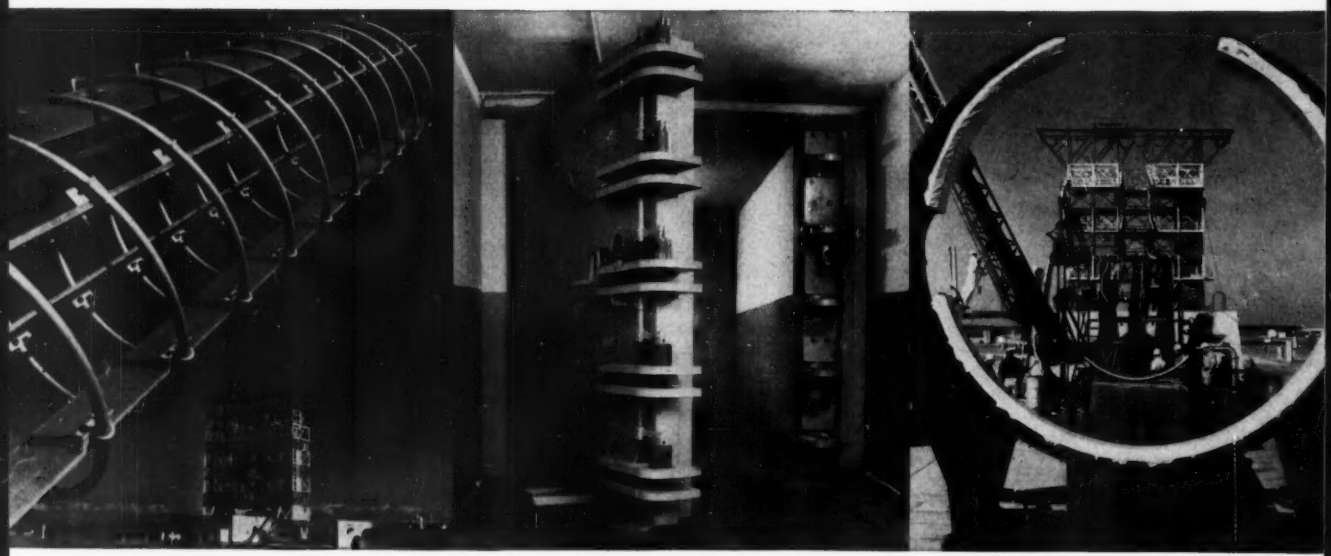
About the earthly side of Canaveral—Only recently, it spawned little more than snakes and other crawling creatures. Today, high flying birds are poised there, and because they can't jump off from sand, most of the Canaveral manpower and materials go into ground support equipment. And virtually all the steel material required can be purchased from one source—United States Steel. Whether we're talking about carbon steel, high-strength low-alloy steel, constructional alloy steel, or stainless steel, steel fence, electrical cable, wire rope or cement,



On this vertical oscillating radar tracking unit, every nut, bolt, and insulator collar is Stainless Steel. To the right, is a Stainless Steel fuel tank, and beyond that rises the U. S. Air Force Thor gantry tower, with a structural steel frame similar to a nine-story building.

The door to the U. S. Air Force Atlas blockhouse weighs 24 tons. It is solid manganese steel about eight inches thick. At X minus 15, the door automatically locks and it is blast-proof and vapor-proof.

The mobile transporter for the Thor is strong but light on its wheels because it was designed with weight-saving high-strength steels. Slanting to the left is the steel umbilical tower which carries Stainless Steel fuel lines and control lines.

United States Steel maintains the technical services to provide the proper assistance to cope with any problem on these materials for ground support. When a ground support program is still on the drawing board, consult

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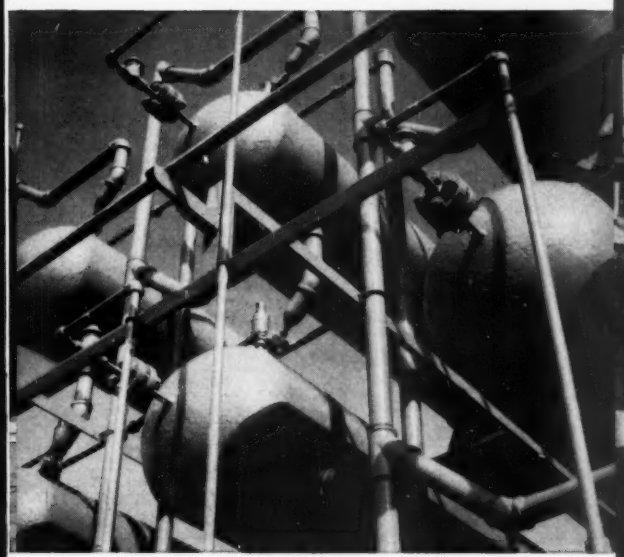
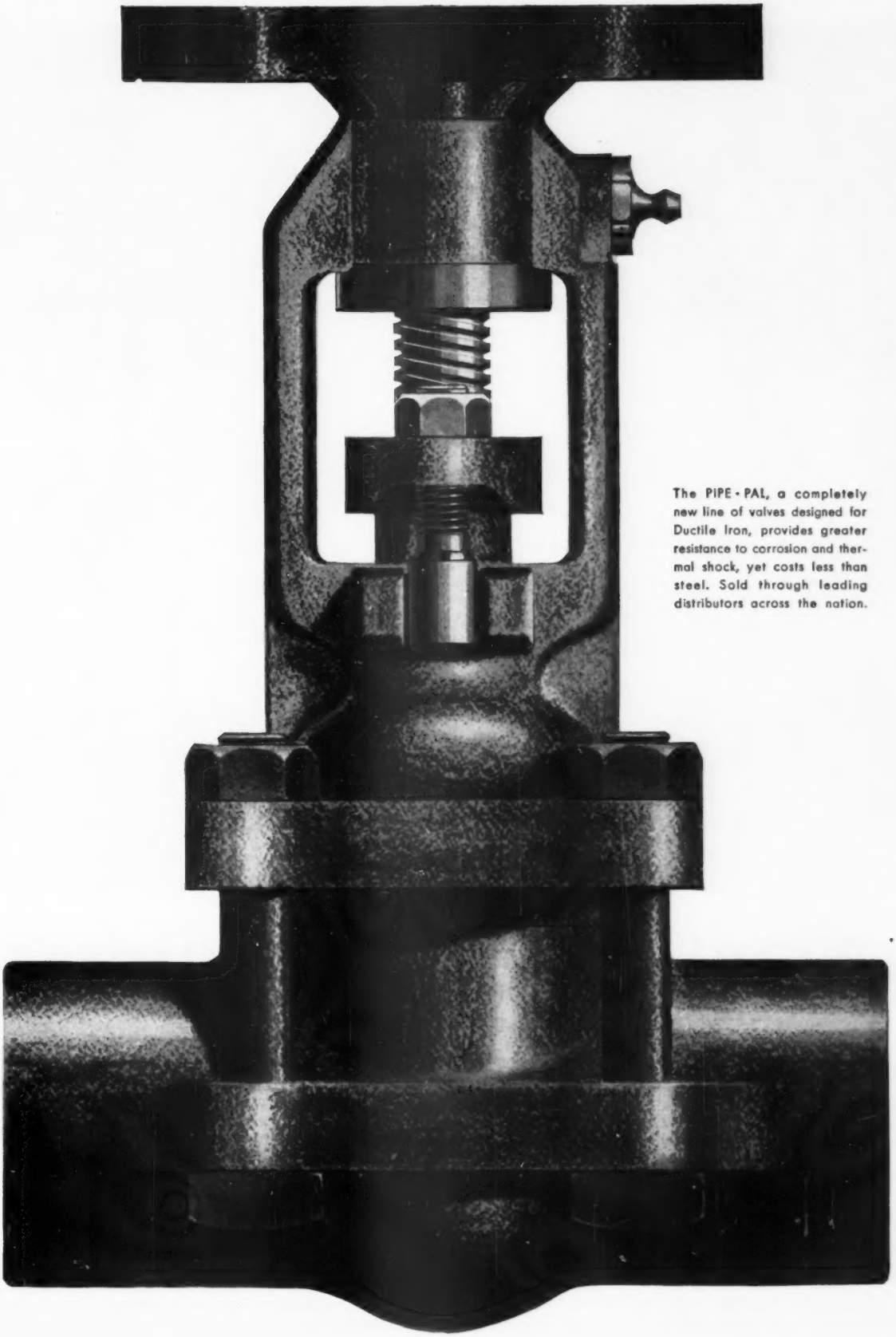
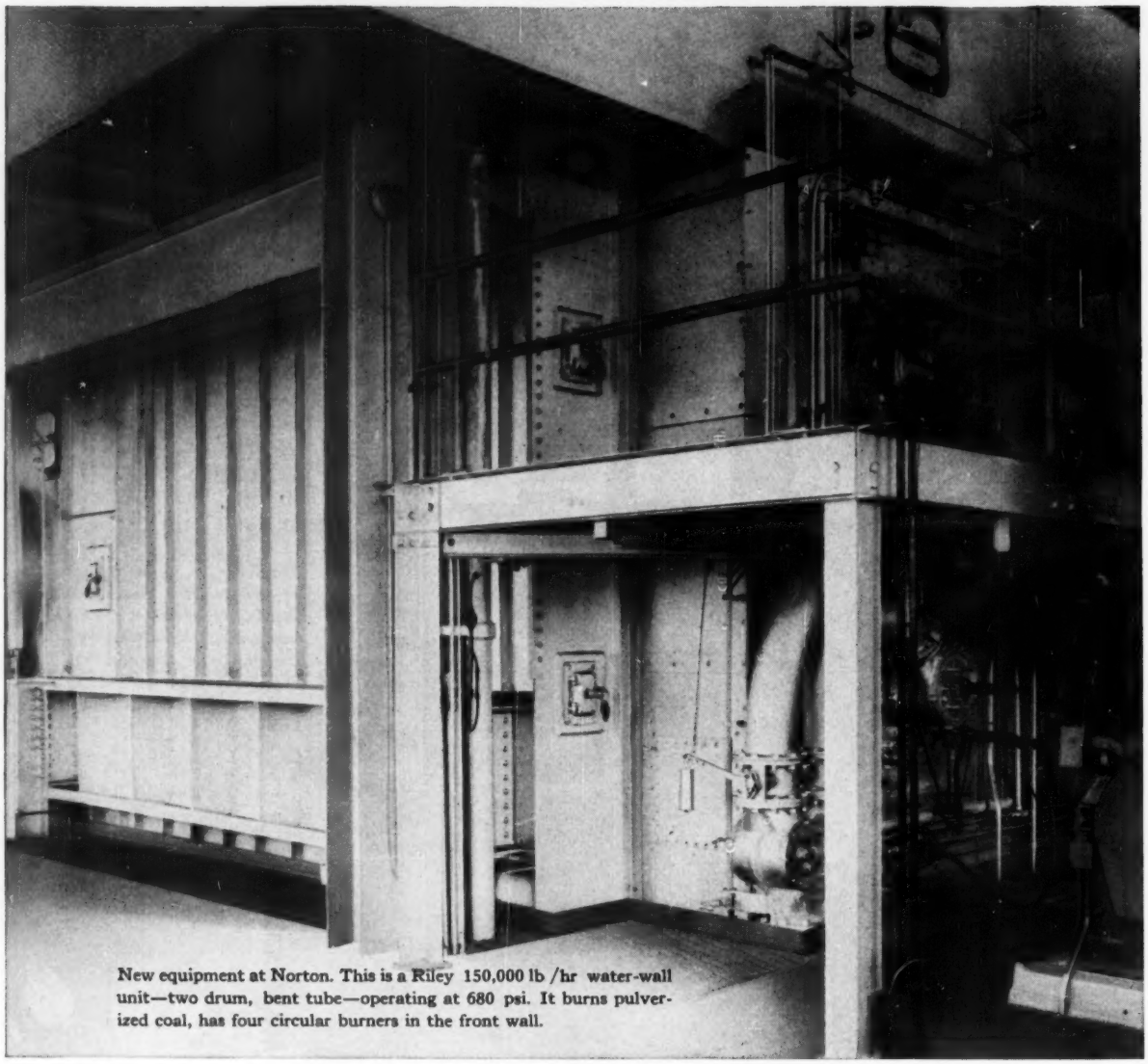


These pressure vessels for the U. S. Air Force Bomarc A system are seamless steel cylinders about 20 inches in diameter and 26½ feet long. The cylinder walls are slightly more than an inch-and-a-half thick and will contain gas at pressure up to 4500 psi.

Stainless Steel pipes and Stainless Steel flexible tubing carry the fuel for the Thor complex. Fuel lines must be almost surgically clean to prevent explosions and assure proper flow. Inspectors check the lines with everything from microscopes to ultraviolet lamps. ▶



The PIPE-PAL, a completely new line of valves designed for Ductile Iron, provides greater resistance to corrosion and thermal shock, yet costs less than steel. Sold through leading distributors across the nation.



New equipment at Norton. This is a Riley 150,000 lb /hr water-wall unit—two drum, bent tube—operating at 680 psi. It burns pulverized coal, has four circular burners in the front wall.

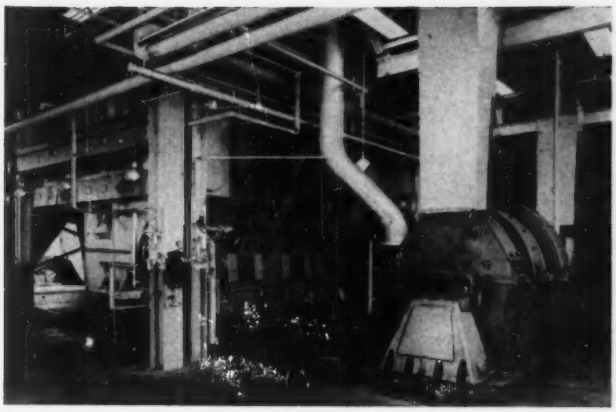
Coal proves best dollar

NORTON COMPANY FINDS COAL STILL IS LOWEST COST

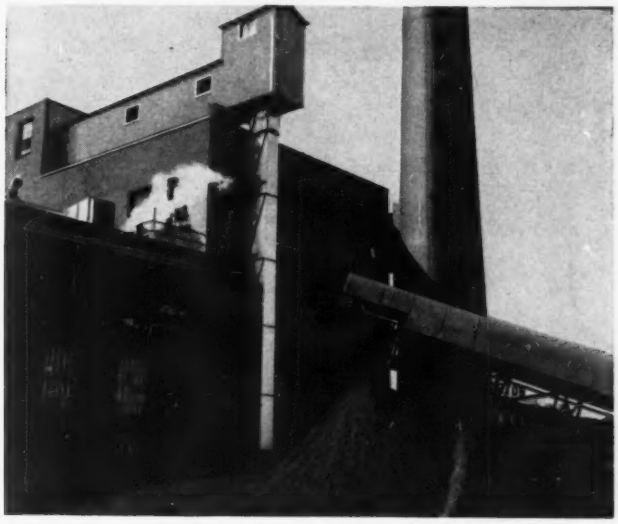
As plant facilities expanded, the Norton Company, Worcester, Mass., world's largest manufacturer of abrasive products, required greater quantities of steam for heating, hot water, electricity and process work. This expansion prompted an engineering survey to determine future power needs. As a result, Norton staff engineers —working with K. R. Warrington, Consulting Engineers—decided to install additional steam generating equipment. Coal had been used previously because it was the most economical of the fuels in that area when the original plant was installed. Coal *continues* as the fuel of the new plant for the same reason. Norton management is sold on the fact that, dollar for dollar, coal is its best fuel buy.

COAL IS LOWEST COST FUEL

Today, *when the annual cost of fuel often equals the original cost of the boilers,* you should know that bituminous coal is the lowest cost fuel in most industrial areas. And modern coal-burning equipment gives you 15% to 50% more steam per dollar, while automatic operation trims labor costs and eliminates smoke problems. What's more, tremendous coal reserves and mechanzied mining procedures assure you a constantly plentiful supply of coal at stable prices.



In the center, ash hoppers—part of United Conveyor steam vacuum ash handling system—lead to underground conveyor which moves ashes to outside storage silo. At right: coal pulverizers.



From track hopper, 100 ton/hr boom conveyor (right) carries coal to storage area. Bucket conveyor (center) lifts it to belt conveyor at top of plant. Coal handling system by William T. Donovan Co. and Jeffrey Manufacturing Co.

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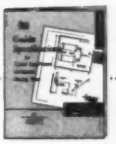

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Our Pleasure

Sir:

The University of Wisconsin is again conducting an Institute for Consulting Engineers to be held in Madison June 2-3, 1960. Originally, we were considering discontinuing this institute for one year. However, conferees at the 1959 institute indicated a strong desire to continue this program on an annual basis.

Since your suggestions last year with regard to possible topics and speakers proved to be extremely valuable, I again would appreciate any help you may be able to provide for this year's program.

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Institute Coordinator
The University of Wisconsin
Madison, Wisconsin

Corporate Policy

Sir:

In "From the Editor's Tranquil Tower" of the September 1959 issue you say, "Since most registered engineers who are manufacturer's agents are members of a Founder Society, or NSPE or both, any instance of an agent providing engineering services for nothing or for a ridiculously low fee could be taken before the Board of Ethical Review of his society, if anyone had the guts to do it."

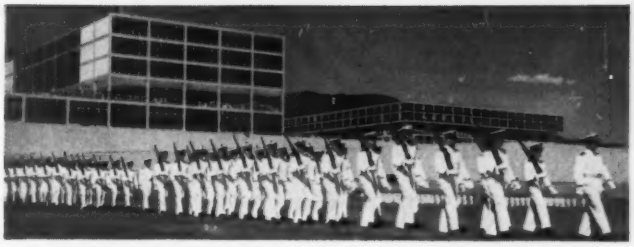
You should be made aware that even when one has the guts to take such action, it may not bring results. I brought a case of highly unethical advertising of engineering services to the attention of ASCE a little over a year ago. The firm in question uses full page advertisements in business magazines which are definitely self-laudatory. Furthermore, this firm, as one of a family of companies, utilizes a highly rated Sunday evening television western as an advertising medium. Even though an ASCE member is a vice president of the company, ASCE could take no action other than to write a letter pointing out the unethical nature of the practice. Evidently the letter did no good, because things did not change.

On further inquiry I found that ASCE can take action only against individual members. Therefore, companies cannot be made to conform to ethical standards unless the head of the company is a society member. Even then action cannot be taken if the organization is on corporate lines. In the case above, the ASCE could not take action against the vice president of the firm, who is a society member, because the companies' actions are governed by the board of directors.

In view of this, how can action be taken against engineers working for a manufacturing firm? In most cases such engineers have even less to say about the policies of their companies than do corporate vice presidents.

In the case of engineering organizations, existing corporations cannot be legislated out of business. Furthermore, this is not desirable since many make an honest effort to be ethical. Legislating the manufacturing companies you speak of

Without breaking step, students march down ramp leading from academic and cadet living area onto the parade ground.



HIGH TEMPERATURE WATER HEATS THE AIR FORCE ACADEMY

Skidmore, Owings & Merrill, Architects; Syska & Hennessy, Inc., Associate Engineers; J. O. Ross Engineering Corp., HTW Consultants

Nestled against the Rampart Range of the Rockies, the Academy presents an impressive sight from the air. Buildings, from left to right, are: Fairchild Hall, the Academic-Library Building, with Aerodynamics-Thermodynamics Lab and Mitchell Hall (Cadet Dining Hall) behind it; Vandenberg Hall, the Cadet Dormitory; Harmon Hall, the Administration Building; Arnold Hall, the Cadet Social Center; and Planetarium (dome at right). The parade ground stretches at left from sloping ramp. The Physical Education Building and athletic fields are at lower right.

Compact and efficient, these three C-E LaMont Controlled Circulation Hot Water Boilers serve in the Academy's Academic Area plant. Each has a rated output of 100 million BTUs per hour.

Nestled picturesquely in the Rampart Range of the Rockies, seven miles north of Colorado Springs, the new U. S. Air Force Academy is a fitting symbol of the prowess and prestige earned by this branch of our military

Situated on a sloping site, the Academy grounds are graded, split-level fashion, into a number of broad terraces. Elevations range between 6,400 and 7,000 feet above sea level. The school is divided into two general areas – one for service buildings and one encompassing academic, physical education, dormitory and hospital facilities.

Selecting a heating system to service these widely-spaced buildings and facilities over the rolling and varying terrain required a type that permitted easy and economical pipe line distribution over individual closed circuits exceeding six miles in length – circuits which totally encompass nearly fifteen miles.

Because of the irregular terrain and the large area, a steam system would have required a substantial number of steam traps and close attention to piping gradients. High temperature water, on the other hand, offered the advantages of smaller-sized piping with no pressure valves, and a smaller, more compact boiler plant than would have been required for steam . . . with 10 to 20 per cent reductions in operating costs.

There are five C-E LaMont Controlled Circulation Hot Water Boilers serving the Air Force Academy. They are located in two separate boiler plants – 3 in one and 2 in the other – and have been performing reliably, efficiently and with minimum operating attention since they were first placed in service in late 1957.

For details on C-E Hot Water Boilers, write for catalog HCC-2 – no obligation, of course.

COMBUSTION ENGINEERING

Combustion Engineering Building, 200 Madison Avenue, New York 16, N. Y.

Canada: Combustion Engineering-Superheater Ltd.

C-246A

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS, FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

out of the engineering business is virtually impossible. Some other solution to the problem must be found or the engineering companies must live with it.

Francis J. Patti
Wantagh, New York

Our Mistake

Sir:

We greatly enjoyed the excellent article "Sextus Julius Frontinus' De Aquis" (CONSULTING ENGINEER, October 1959), and were happy to be able to provide you the article's illustrations, which came from our *Pictorial History of Science and Engineering*. Since you inadvertently neglected to give credit to the source, perhaps you could do this in a future issue.

As you know, in addition to it and other pictorial books, we publish *Year*, the annual picture-history, and *News Front*, the picture news magazine for management.

Since the latter is edited primarily for the top echelons of U.S. industry and government, we would appreciate an opportunity to mention it to CONSULTING ENGINEER's distinguished readership.

Thomas C. G. Simonton
Executive Editor
Year, Inc.
New York, New York

Client Comes First

Sir:

I have had an opportunity to note some of the articles which have appeared in CONSULTING ENGINEER covering specifications and some of the complaints from the manufacturers with regard to these specifications. In thinking of this problem, I assume that probably the next article which will appear will give the consulting engineer some of the things of which he should be cognizant from his clients' standpoint when writing specifications and some of the problems that he will run into in his attempt to serve his client best.

Charles D. Birget
Jackson, Michigan

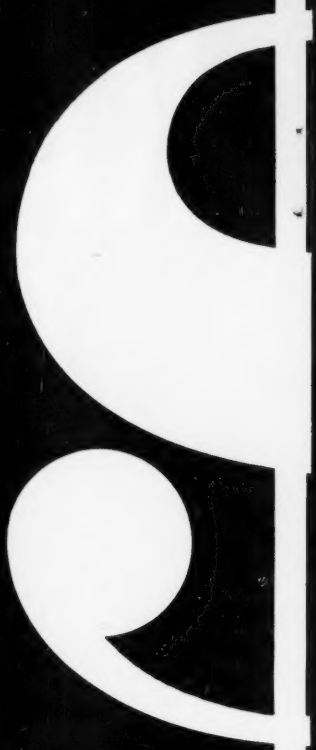
KAISER ALUMINUM

KAISER ALUMINUM RIGID CONDUIT

IS A SURE BET TO LOWER COSTS

BECAUSE...

IT COSTS NO MORE TO BUY



And IT OFFERS COMPLETE ASSURANCE

Contractors everywhere are finding that the old ways aren't necessarily the best ways when it comes to buying and installing rigid conduit. The big money-saver is aluminum . . . for good reasons.

1 *Low initial cost.*

Today, aluminum conduit costs no more than steel . . . an important factor to consider when figuring your bid.

2 *Lower installed cost.*

Aluminum conduit weighs only *one-third as much* as the same size steel conduit. Result: easier handling . . . less worker fatigue . . . easier cutting, threading, bending . . . faster, more economical installation.

3 *Lower maintenance costs.*

Because aluminum conduit can't rust and is highly resistant to corrosion, maintenance and replacement costs are virtually eliminated. Aluminum never needs painting, keeps its look of quality for years. Other quality features: aluminum conduit is nonmagnetic, which reduces voltage drop; non-sparking for safe use in hazardous locations.

IT COSTS LESS TO INSTALL

OF A QUALITY INSTALLATION!

10-ft. section of 4-inch aluminum conduit weighs only 34 lbs.; steel—98 lbs.

Aluminum conduit can't rust, resists corrosion—saves maintenance dollars.

Aluminum conduit is easy to work with—saves labor, time and money.

KAISER ALUMINUM

THE BRIGHT STAR OF METALS

See "MAVERICK" • Sunday Evenings • ABC-TV Network

HERE'S HOW TO START SAVING MONEY NOW...

SEE THIS MAN BEFORE YOU BID ANOTHER JOB!

HERE'S HOW TO START SAVING MONEY NOW...

The man to see before you bid on another job is your Kaiser Aluminum Electrical Distributor. Compare prices—see how Kaiser Aluminum rigid conduit can give you the competitive edge on any contract.

Your Kaiser Aluminum Distributor has a complete stock of aluminum conduit sizes and fittings—*ready right now for delivery to your job site.*

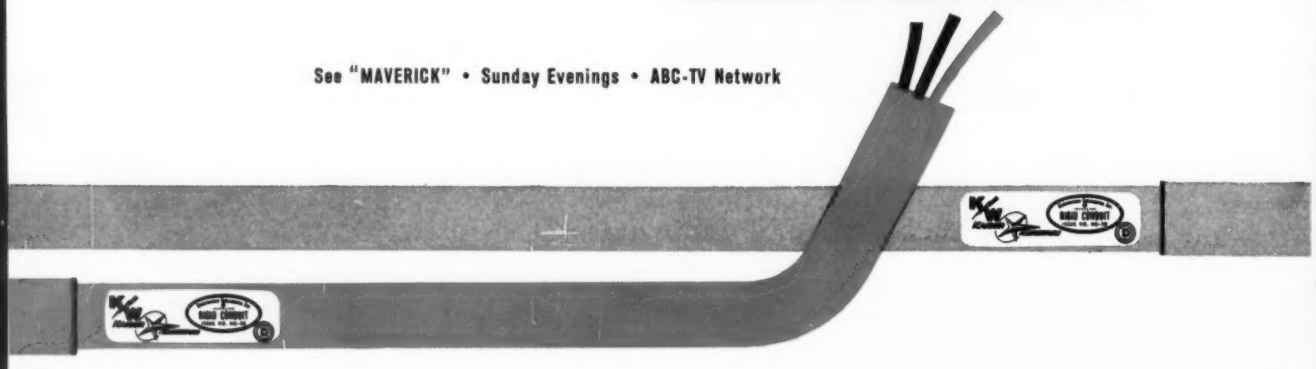
See or call him today. Ask for a free copy of the Kaiser Aluminum Rigid Conduit Brochure containing comparative weights, installation details, and all the facts you need to lower your costs.

Start saving money now!

Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

KAISER ALUMINUM
THE BRIGHT STAR OF METALS

See "MAVERICK" • Sunday Evenings • ABC-TV Network



The Readers' Guide

Dome Structures A Special Report

(page 89)

The public has become dome-conscious during the past few months. Few major publications have failed to mention domed buildings in recent issues, and not only the reader at home but the traveler on the road is made aware of domed structures as they rise suddenly before him on the skyline. Most of these new buildings are beautiful, and they are good examples of what can be done when engineers and architects combine their creative talents. At the same time, we can hope that this dome shape is not to be overdone so that it becomes a sort of architectural pimple representing yet another adolescent stage of structural design. Much of the credit for the current craze goes to R. Buckminster Fuller, father of the geodesic dome. Fuller is a man much written about, but he does little writing himself. We are, therefore, especially proud to be able to give our readers a good idea of the way this unusual man thinks by presenting his own ideas in his own words as an introduction to this month's Special Report on domed structures. Fuller is, at times, rather hard to follow, and the reader must look for his concepts in his presentation of abstract ideas rather than in his conventional mathematics. Whether one agrees with his ideas or with his way of putting them, no one could fail to detect, in reading this introduction, a type of genius that is all too rare today. Fuller has about him something of the Universal Man, a reminder of the Renaissance, a mind that comprehends fundamentals and forgets details. This is not the usual engineering intellect, but it represents a type of thought that must precede the application of the scientific method. The reader should note also that all new dome structures are not based on Fuller's geodesics, and all dome engineering problems are not structural. The electrical and mechanical engineer and the acoustical specialist have their own problems, many of them major. These nonstructural aspects of domes we have covered, too. In fact, the reader will find that despite the great number of words that recently have been written on domes, this Special Report covers the topic as nothing else yet published has. It is a report we are proud of and one well worth the time and attention of every consulting engineer.

Preliminary Budget Estimates

(page 86)

It would be hard to estimate the dollar value of construction projects that failed to materialize because of inaccurate budget estimates – and there are two sides to this coin. If the estimate is high, the project may be eliminated entirely. If the estimate is low, the project may be carried out at a level of quality or scope below that which the client originally had envisioned – and had the funds to provide. Herbert F. Shatzman, of Seelye Stevenson Value & Knecht, consulting engineers of New York, describes the qualifications that an estimator must have to coordinate the engineering and construction phases of a project in order to arrive at a reasonable budget estimate. He not only warns of the pitfalls, but makes positive suggestions for improved procedure in making engineering estimates.

File It And Find It

(page 124)

The problem of cataloging technical information is receiving serious attention by many interested parties, including the Federal government and its various military agencies. It will not be long before computerized literature searches will be practical. However, the consulting engineer has the same problem, on a smaller scale, within his own organization. He cannot take the time to go to a central source, nor can he afford a highly automated system for his own use. Daniel I. Weinberg, of Astra, Inc., Raleigh, North Carolina, describes a simple punched card system which required an investment of less than $100. It depends on hand sorting with a sorting rod and alignment block, but gives an amazing amount of flexibility to the firm's cataloging system which covers everything from manufacturer's literature to tearsheets of magazine articles.

Now—a new appearance concept for low-budget commercial installations

The "Power-Plant" Look

with Johns-Manville FIBROCEL Insulation!

Now you can bring the traditionally fine appearance and performance excellence of your power plant work to general commercial and industrial installations... with Johns-Manville Fibrocel® Insulation!

Why these power plant advantages? Simply because Fibrocel is molded! The only commercial insulation made (by a precision metal mold) to near-perfect roundness, with unmatched uniformity of size and line.

This means an immediate end to costly finishing, heavy jacketing, needless pointing up of cracks and apertures. Instead, Fibrocel gives you a tighter, better looking installation just as it is applied. Pipelines are gun-barrel straight, firm end to end. The look of a power plant!

Fibrocel's dimensional uniformity again pays off in fuel savings—pipe is always "dead center," with lengths butted tight to provide maximum insulating effectiveness.

Let us send you the informative new brochure, IN-155A. It gives you full details on Fibrocel's thermal performance. Illustrations show why Fibrocel installs easier . . . takes abuse, too. Keeps its fine appearance and performance excellence for the life of the installation. Write for it today!

Address Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

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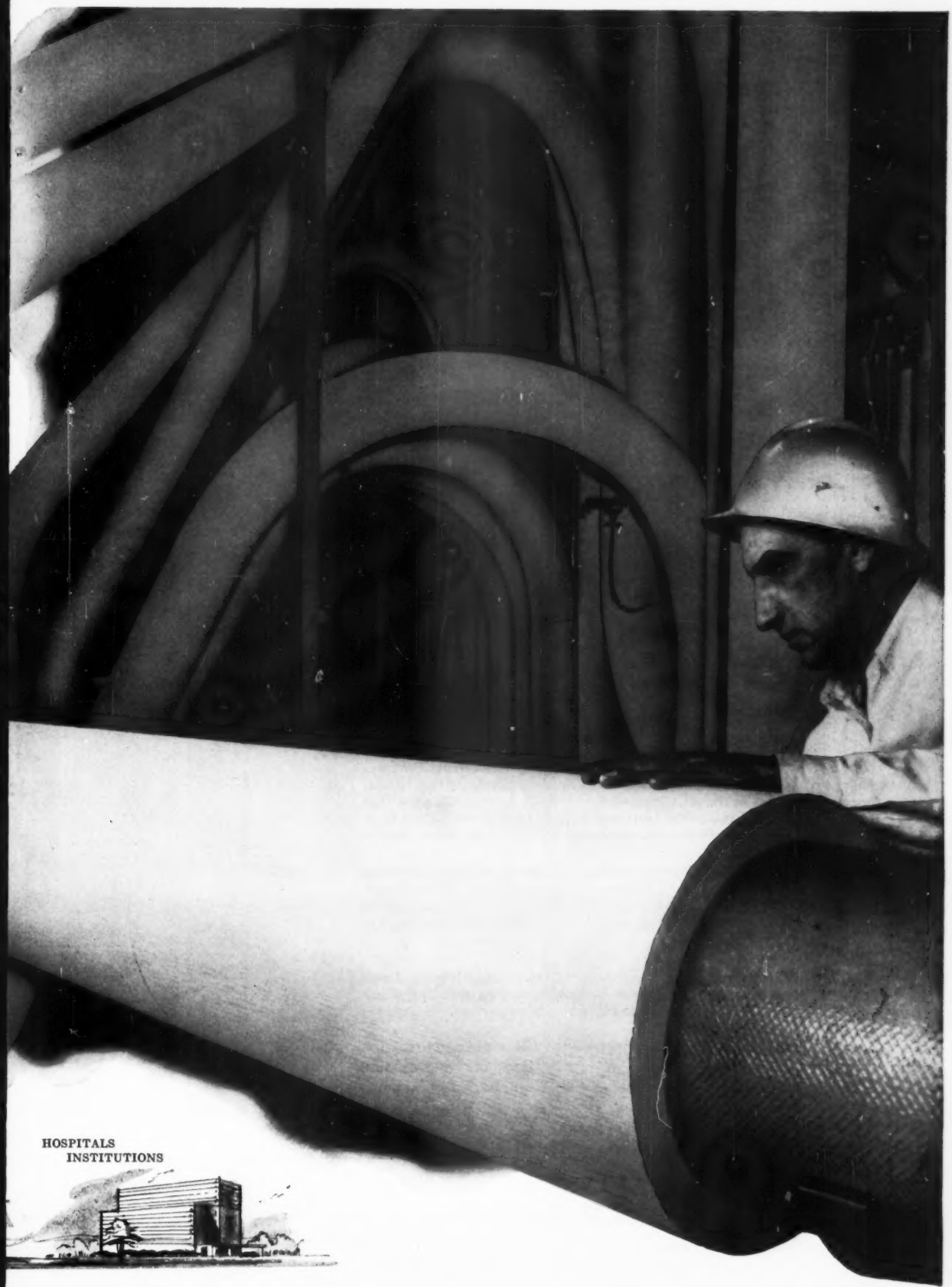
...Specify Fibrocel for the "POWER PLANT" look in installations like these (35F to 300F)



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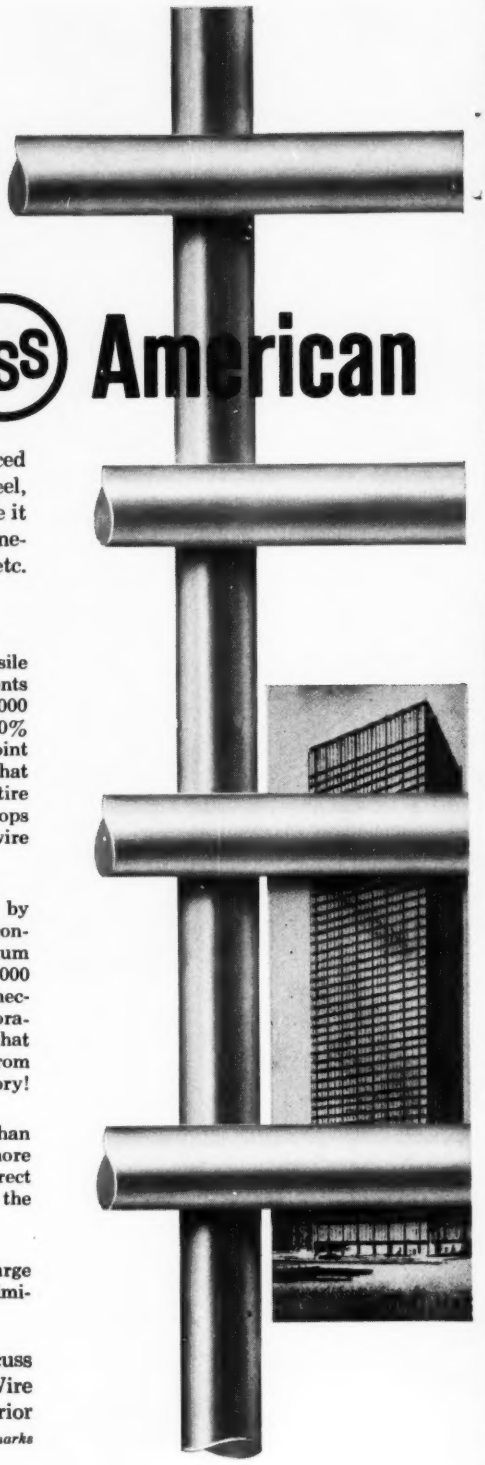
INSTITUTIONS

It's new...
it's big...
it's strong...

extra-heavy ½ inch USS American



Welded Wire Fabric is now available with ½" diameter wires spaced as close as 2" on centers in both directions! These new areas of steel, plus the many time-tested advantages of Welded Wire Fabric, make it the ideal structural reinforcement for all types of construction—one-way slabs, two-way flat plates or flat slabs, walls, slabs on grade, etc.

Consider these advantages:

1. American Welded Wire Fabric is produced from cold-drawn high tensile steel wire. This wire is carefully produced to conform to the requirements of ASTM Specification A82-58T. The minimum tensile strength is 75,000 psi and the minimum yield point, as defined in this specification, is 80% of the tensile or 60,000 psi. Actually, cold-drawn steel wire has no yield point in the conventional sense—no sudden excessive elongation. This means that cold-drawn wire tends to resist stress practically throughout its entire strength range without revealing any sudden elongation such as develops in a typical hot-rolled bar. This physical advantage of cold-drawn wire makes it the ideal concrete reinforcement.

2. American Welded Wire Fabric is completely machine prefabricated by electrically welding all wire intersections. The strength of these welds conforms to ASTM Specification A185-58T which requires that the minimum average shear value of the weld in pounds shall not be less than 35,000 multiplied by the area of the longitudinal wire. This high-strength connection assures positive "mechanical anchorage" in the concrete. In fact, laboratory tests reported in the ACI Proceedings, Vol. 48, April, 1952, show that this anchorage is so good that fantastically high bond stress values from 1000 psi to 2700 psi are computed using conventional bond stress theory!

3. American Welded Wire Fabric is prefabricated with greater accuracy than can normally be relied upon in field work. The wires may not vary more than ¼" center-to-center than the specified spacing. This assures correct placement and distribution of the steel. Also, the wires are drawn to the very close tolerance of 0.003".

4. American Welded Wire Fabric requires very little on-the-job tying. Large prefabricated sheets are shipped to the job and placed as a unit. This eliminates thousands of ties and results in important labor savings.

The representatives of American Steel & Wire will be pleased to discuss with you the many advantages and applications of Welded Wire Fabric. Just contact American Steel & Wire, Dept. 9318, 614 Superior Ave., N.W., Cleveland 13, Ohio. *USS and American are registered trademarks*

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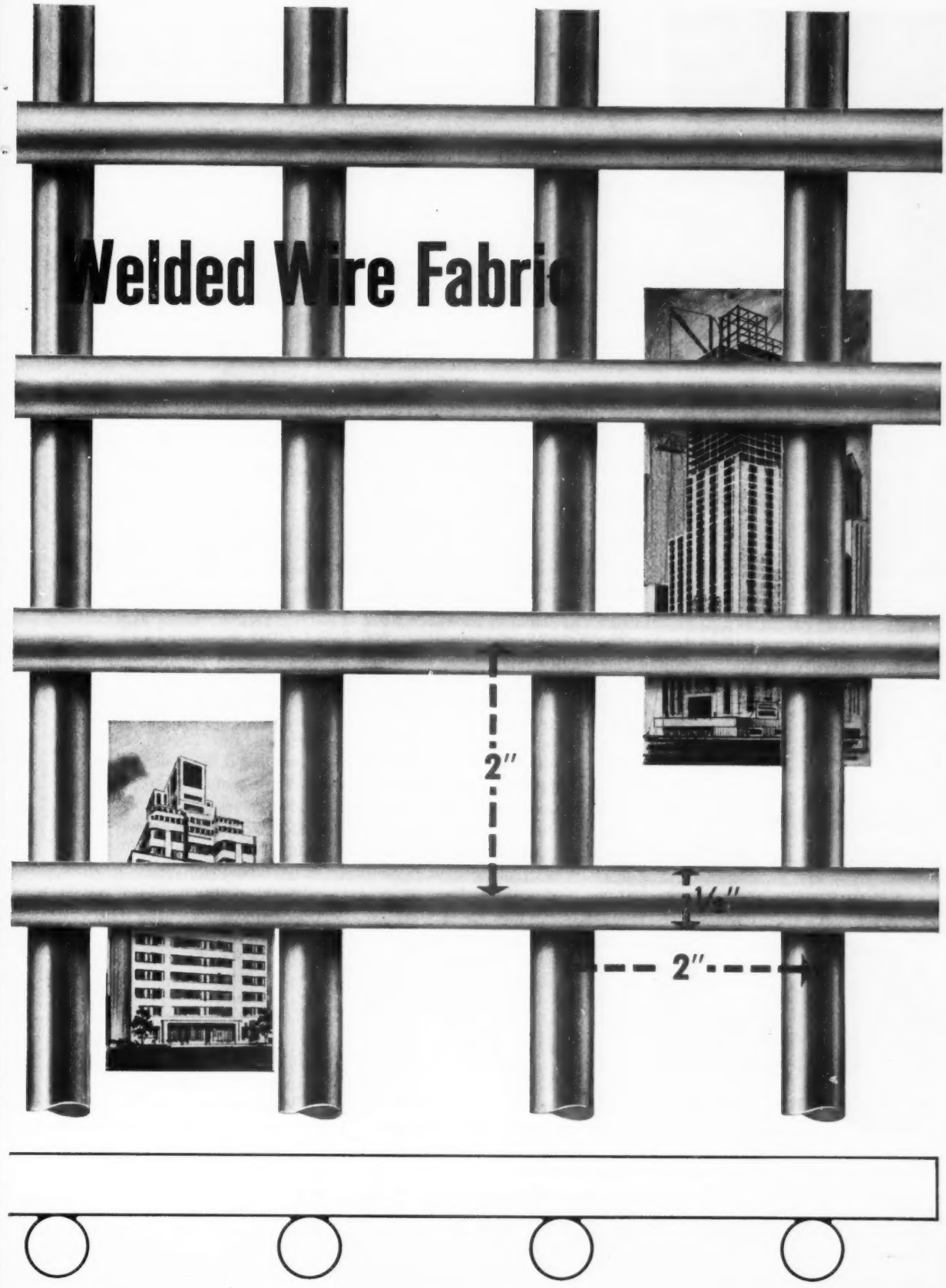

Welded Wire Fabric
2"
1⅛"
2"

The Legal Aspect

MELVIN NORD, P.E.
Consultant in Legal and Technical Problems
Patent Attorney

The Law of Real Property: Urban Redevelopment & City Planning

EMINENT DOMAIN is closely tied in with the entire subject of urban redevelopment and city planning, since both normally require the condemnation of large amounts of real property. A few relatively recent cases illustrate the legal problems involved in urban redevelopment and city planning.

Urban Redevelopment Statutes

Velishka v. City of Nashua, 106 Atl. (2d) 571, a New Hampshire case decided July 1, 1954, involved the constitutionality of a statute providing for the redevelopment of blighted areas.

The state statute gave the city housing authority the power to condemn blighted areas, clear the land, and sell or lease the cleared land to private persons subject to conditions consistent with the redevelopment plan recommendations at the land's "use value."

One of the grounds of attack on the statute was based on the fact that the plaintiff's property was not in itself "blighted property," although it was admittedly in a blighted area. The court rejected this argument, holding that the city has power to condemn all property in a blighted area for redevelopment, regardless of whether each individual piece is itself blighted.

The plaintiff also attacked the broad discretionary authority granted the housing authority for determining what a blighted area is, claiming that the lack of specific directives to the housing authority was an improper delegation of power by the legislature. The court also rejected this argument, stating that the nature of the subject matter made it necessary to grant the housing authority broad discretionary powers.

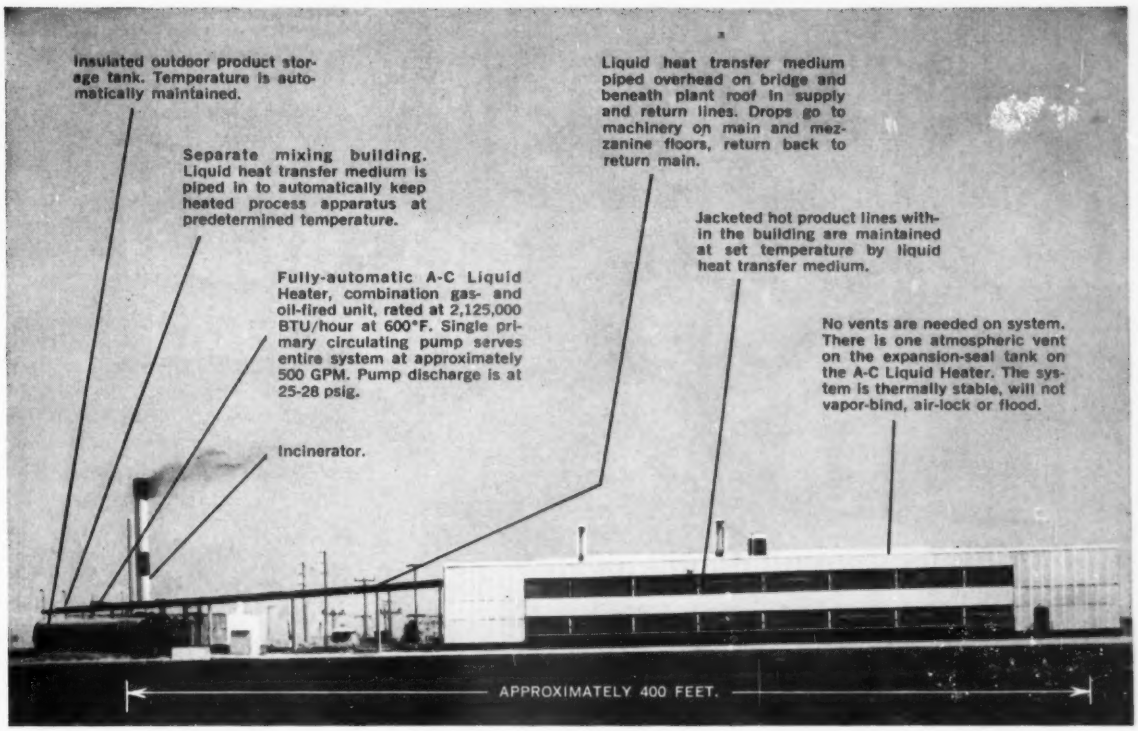
Finally, the plaintiff argued that since the cleared land could be sold to the private purchasers at a "use value" which was less than the cost to the city of acquiring and clearing the land, this amounted in essence to an illegal gift to such purchaser. The court also rejected this contention, holding that if a purchaser paid the fair "use value" and was subjected to conditions requiring him to use the land in a manner consistent with the redevelopment plan, this was sufficient.

Thus, the constitutionality of the statute was upheld.

Asch v. Housing & Redevelopment Authority of St. Paul, 97 N.W. (2d) 656 was a taxpayer's suit seeking to nullify proceedings of the city housing authority by which land previously condemned as a blighted area was later resold to a private corporation, and to have the statute authorizing the proceedings declared unconstitutional.

The court held that the resale of property to a private individual, according to a redevelopment plan, is legitimate, and upheld the proceeding and the statute.

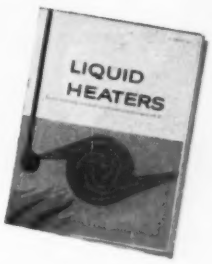
These and many other cases clearly establish that the mere fact



HOW ONE ALLIS-CHALMERS LIQUID HEATER SERVES AN ENTIRE PROCESSING PLANT

In this West Coast plant, one Allis-Chalmers Liquid Heater automatically furnishes indirect process heat for all mixing and processing operations and outdoor storage tanks. The liquid heat transfer medium is pumped at low pressure for a distance of approximately 400 feet and returned by a standard, low-head centrifugal pump. All safety valves, relief valves and similar devices are eliminated, and there are no explosion hazards. A-C liquid heating systems provide maximum safety at minimum cost.

If higher processing temperatures, automatically controlled and delivered at low working pressures, can help increase your client's output and cut production costs, you'll want to learn more about this liquid heating system. It is economical to install and operate, can be applied to existing equipment as well as new construction. For bulletins containing complete information, contact your nearest Allis-Chalmers office, or write directly to Allis-Chalmers, Hydraulic Division, York, Pennsylvania.



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that some private interest may derive an incidental benefit from the activity does not deprive the activity of its public nature if its primary purpose is public. The majority of states now have urban redevelopment statutes, and the overwhelming majority of the court decisions have upheld the constitutionality of these statutes.

City Planning Laws

There are two principal types of legal problems involving the validity of city planning laws. One pertains to the relation between city planning laws and zoning ordinances. Zonings in general will be covered in a future article. The other problem pertains to the relation between city planning laws and eminent domain.

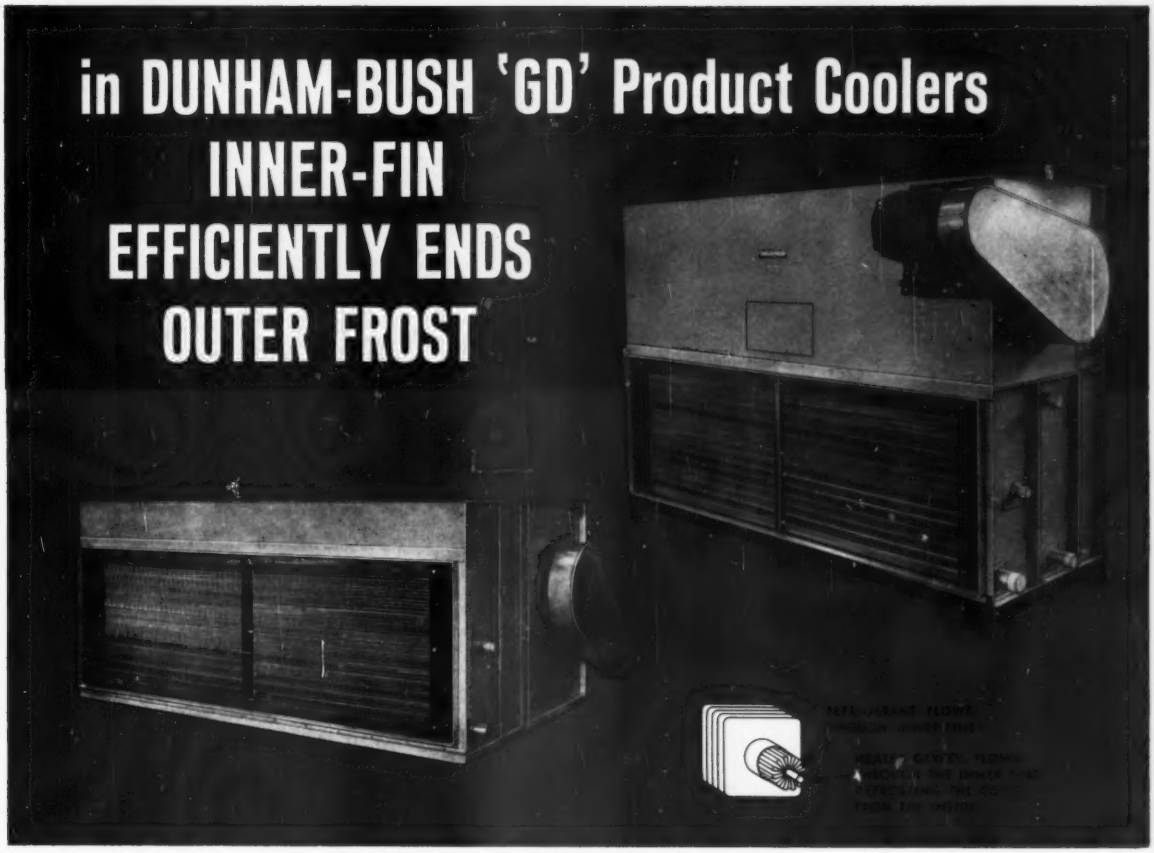
As an illustration of the latter problem, we may consider the case of *Van Patten v. City of Omaha,* 94 N.W. (2d) 664, a Nebraska case decided February 6, 1959.

This was a proceeding by the city to condemn land for the purpose of extending an arterial highway one block to the airport. The owners of the property attempted to prevent the condemnation of their property by pointing out that no recommendation of the city planning commission had been given or obtained, as required by the provisions of the statute.

The statute in question provides that the city planning commission shall acquire or prepare a city plan and shall have the power to carry its recommendations out after its adoption by the city council.

The court held, however, that this statute had no bearing on the present case. The purpose of this statute is merely to make a city plan legally effective after its approval by the city council; before that time the city planning commission is merely advisory to the city council. Thus, the fact that the city planning commission had never prepared any plan which covered this particular property was held to be irrelevant. ▲▲

in DUNHAM-BUSH 'GD' Product Coolers INNER-FIN EFFICIENTLY ENDS OUTER FROST



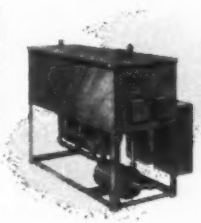
...and provides entirely separate defrosting circuits

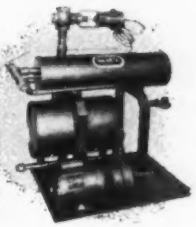
Dunham-Bush Glycol Defrost coolers, available in floor-mounted and ceiling-suspended models, feature famed Inner-Fin high efficiency coils, one of the most beneficial advances in heat transfer.

Patented Inner-Fin construction rapidly distributes heat to points of critical frost formation, resulting in faster, more efficient defrosting with minimal rise of room temperature. Such performance is especially advantageous in warehouses holding perishables, meat-packing plants, and ice cream storage areas.

Additionally—as the 'GD' demonstrates—Inner-Fin enables more compact design and provides an entirely separate defrosting circuit . . . advantages possible with *no other equipment intended for similar application.* The separate circuit contains the glycol completely, preventing dilution of the defrosting medium and eliminating costly necessities of distilling and regular replenishment. Also prevents air contamination by the defrosting medium. (For Direct Expansion Ammonia unit, specify models 'GDA'.)

Totally, what the 'GD' offers you is an integrated combination of features engineered to maximize efficiency. Get more information on the 'GD' and other heavy-duty coolers in the complete Dunham-Bush line. Contact the Dunham-Bush Sales Engineer near you.





GLYCOL HEATER KITS
The defrost circuit comprises a glycol pump, shell type heat exchanger, timer, and magnetic contactor—all supplied as an assembled kit. To minimize glycol heat losses, station kits outside refrigerated area, as close to 'GD' units as possible. Kits available for use with electrical (GEH) or steam heating (GSC) of glycol.

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AIR CONDITIONING • REFRIGERATION • HEATING • HEAT TRANSFER

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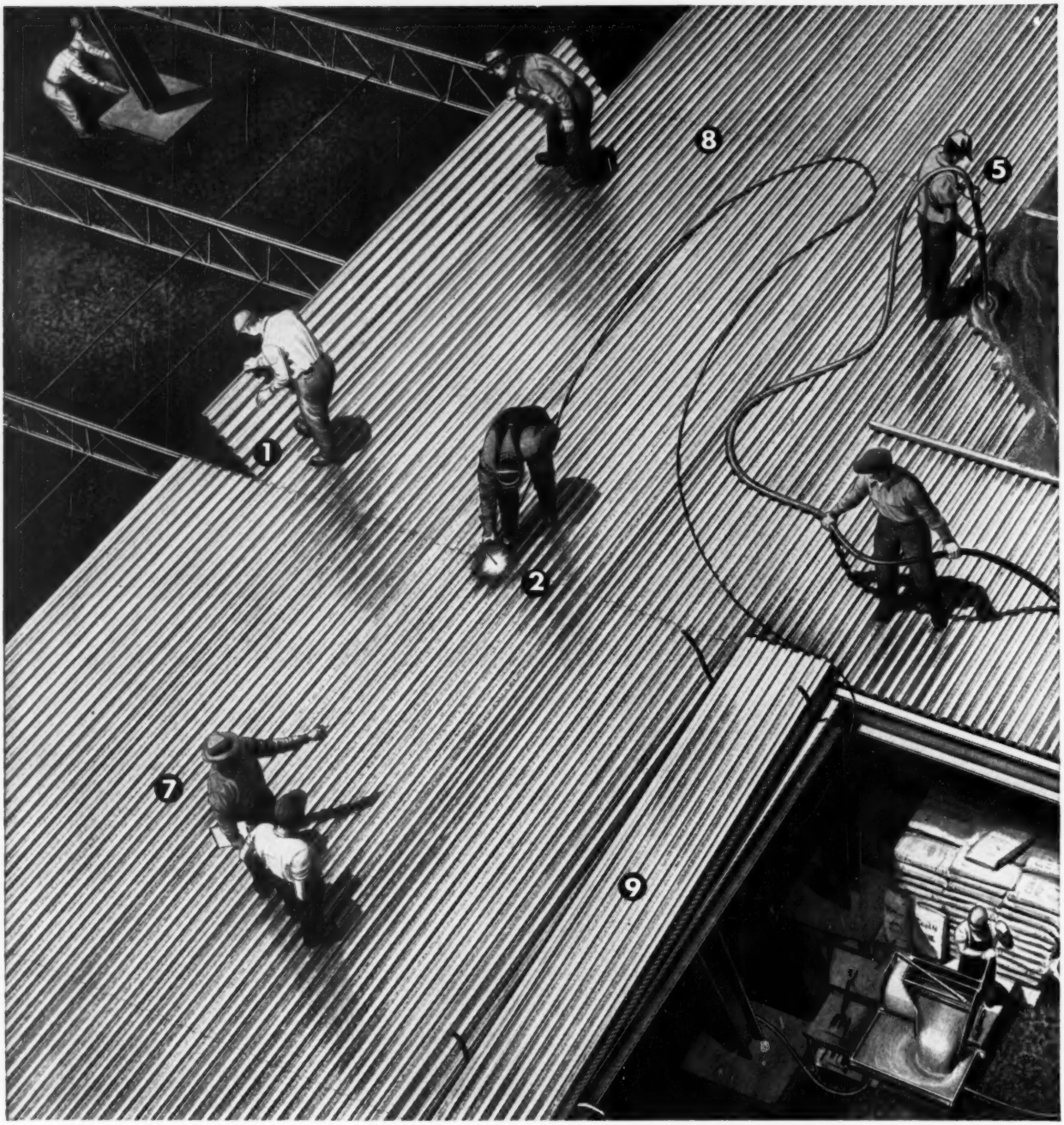
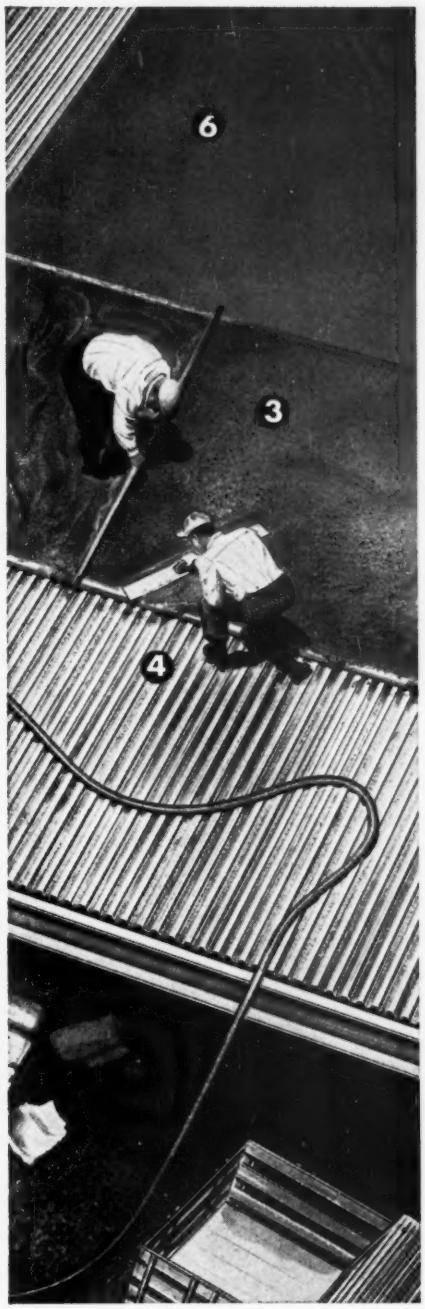
How a Tufcor® roof system



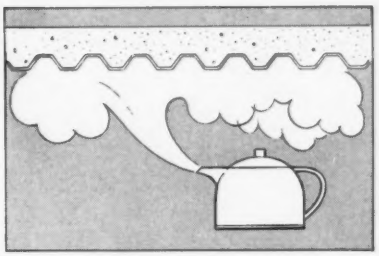
CHECK THESE TUFCOR FEATURES

1. **EASY TO INSTALL.** Rigid sheets fall quickly in place, arrive at job in convenient bundles.
2. **FAST PLUG WELDING.** Long 21'6" sheets cover up to 48 sq. ft., mean fewer laps and welds.
3. **GREATER STRENGTH.** Tufcor roof system provides safety factor of 5 to 10 times design load.
4. **SAFE WORKING PLATFORM.** Trades move in as soon as sheets are welded in place. No planking needed.
5. **FAST PLACING OF INSULATION.** As quickly as placing sheets! Less labor. Faster job completion.
6. **FIRM ROOF BASE.** Rigid system provides flat base for built-up roof, speeds roof application.

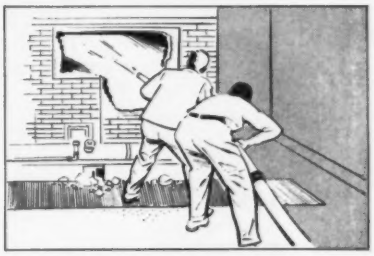
saves money in every stage of construction



Check features. Compare with other systems. You'll see why Tufcor provides the lowest-cost roof assembly available. Construction is finished in three steps: (1) place Tufcor; (2) pour insulation; (3) apply built-up roof. Many qualified lightweight insulation applicators are now available to do an expert job. Consider, too, services you get from the producers of Tufcor. Granco pioneered in developing present-day floor and roof systems... maintains continuous research to keep its engineers, salesmen and distributors up-to-date on roof construction techniques. Like more information? Simply mail the coupon below.



VAPOR BARRIER. Tufcor prevents penetration of warm, moist air, keeps insulating concrete dry and effective. No wall vents or ceiling insulation needed. Heating and air conditioning costs are reduced.



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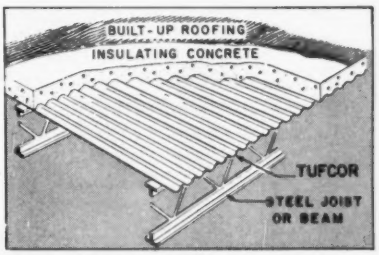

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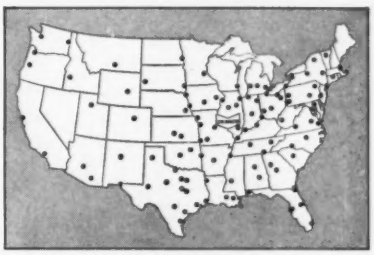

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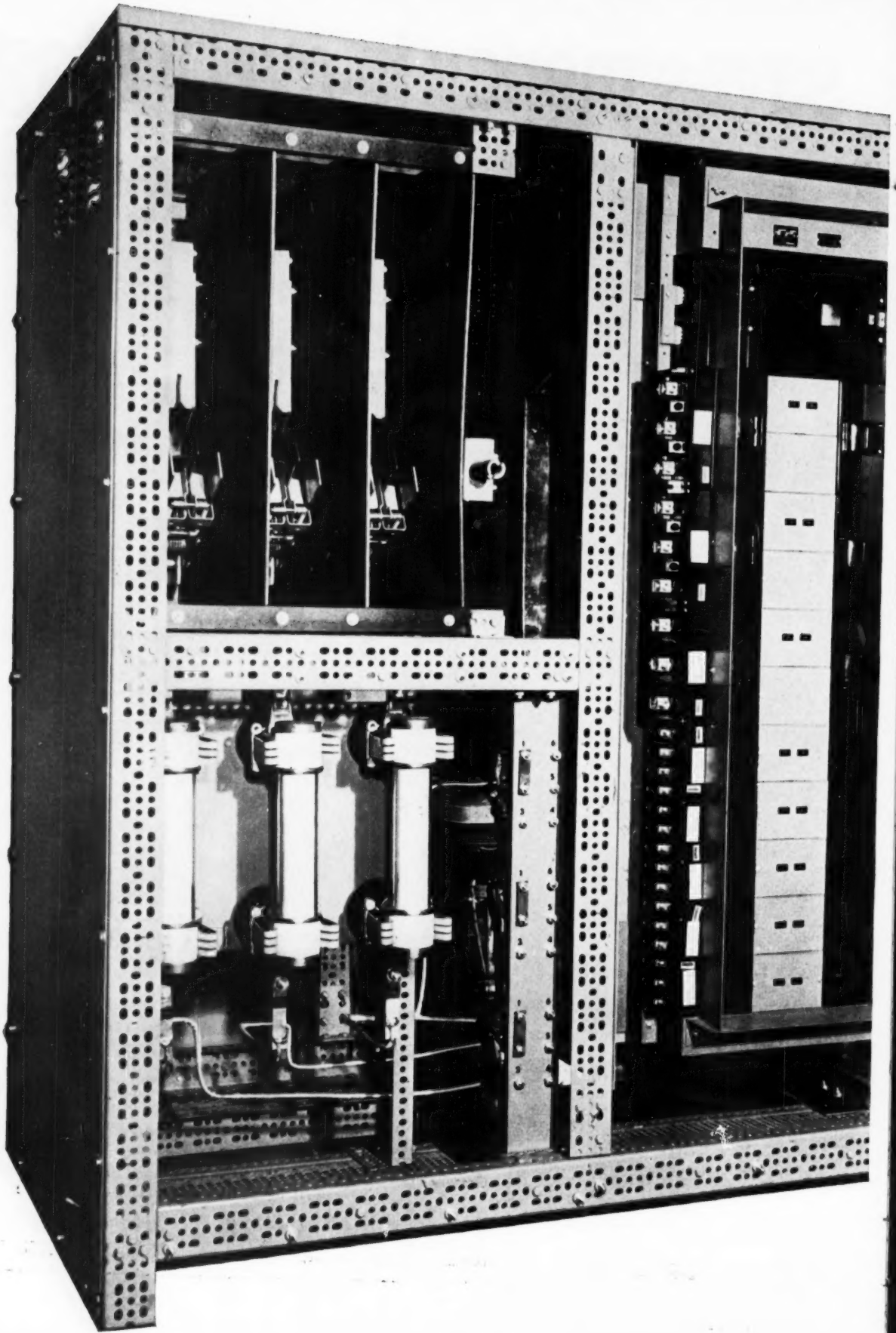
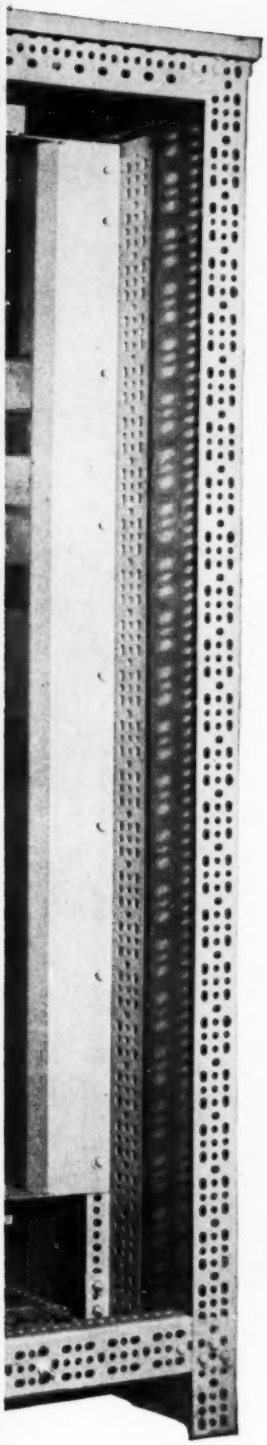


new General Electric Integral Distribution Center



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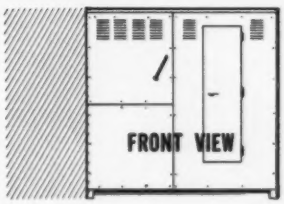

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Q. Isn't it unusual to recommend pneumatic controls for the smaller installations? I always thought pneumatic controls were for the big jobs only.

A. Not at all. Johnson has always done work in buildings of all sizes. Naturally, you hear more about the big "name" jobs, but every year Johnson also furnishes pneumatic controls for thousands of small and medium size heating and air conditioning installations.

Q. To be practical, how small can a building be and still use a pneumatic control system?

A. Since building *size* has nothing to do with building *quality*, size isn't the problem at all. A quality-built *small* building needs just as good a control system as a first class *big* building. That means *pneumatic* controls if you want to give your clients big-system standards of comfort, efficiency and economy.

Q. What help does Johnson offer the engineer and the architect?

A. Johnson accepts complete responsibility for all control work. A Johnson engineer will plan a control system to meet your exact needs, no matter how small the job. His recommendations are backed by the Johnson organization's 74 years' experience with all types of systems and all makes of equipment. Likewise important, all installation work is done by Johnson's own full-time installation mechanics. There's no need for you to spend valuable time on planning, estimating, supervisory or installation details. Thus, Johnson helps simplify your work, saves your time and gives your client a top notch control system.

Q. What advantages does the owner get from pneumatic control systems?

A. They are much simpler and involve fewer components than other types. They require less supervision and are easier and less costly to maintain. Since each system is specially planned, they assure the greatest long range economy in the operation of heating and cooling systems. And, of course, nothing else combines the accuracy and dependability of pneumatic controls.

Q. Who does the owner look to for service when he uses pneumatic controls?

A. A good question and especially important to the smaller owner. Johnson backs its systems the way you wish all manufacturers could—by our own full-time, factory-trained mechanics, whose only job is the maintenance and repair of Johnson equipment. These men are stationed in over 200 cities. Nobody in industry gives better or more complete service than Johnson.

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Report from the West Coast

RALPH S. TORGERSON
West Coast Editorial Representative

AN OUTSTANDING technical program drew an attendance of 526 to the annual convention of the Structural Engineers Association of California, held at Coronado. Consultants in private practice al·ways have taken a prominent part in the activities of the association, which has about 1250 members, and this again was evident at the technical sessions.

Seismic Design Manual

On October 2, 1958, the Board of Directors of SEA approved a statement covering "Recommended Lateral Force Requirements" for earthquake design. Later the 1959 Seismology Committee was asked to develop a manual as an elaboration and guide to its application.

Charles DeMaria, president of the Structural Engineers Association of Northern California, presided at the first technical session during which this "Manual of Standard Practice in Seismic Design" was discussed by John Rinne and Herman Finch. The manual is not intended to be a compendium of all knowledge on earthquake design, nor is it a handbook for the inexperienced engineer. The earthquake phenomenon is complex in its manifestations, and codes providing minimum design criteria are, of necessity, simplified. The good judgment of the experienced structural engineer must be relied upon for specific structures, even after recognizing the advances in knowledge in recent years.

It is expected that the manual, soon to be published, will have state-wide acceptance by engineers and governmental bodies. Herman Finch said that the format calls for a series of brief topics, arranged so that reference can be made to any portion without complete study. The arrangement will be logical rather than alphabetical.

Reinforced Concrete Research

Leo H. Corning, of the Portland Cement Association, outlined his association's program of research in seismic design of multistory rein-

forced concrete buildings. John A. Blume, consulting structural engineer, San Francisco, and Dr. N. M. Newmark, head of the Civil Engineering Department, University of Illinois, were retained as consultants and principal authors of the contemplated PCA manual.

Corning referred to conferences arranged with members of the SEA Seismology Committee, representing north, south, and central regions, at which an alternative Section (j) was worked out in April 1959. This section, covering reinforced concrete design, now reads:

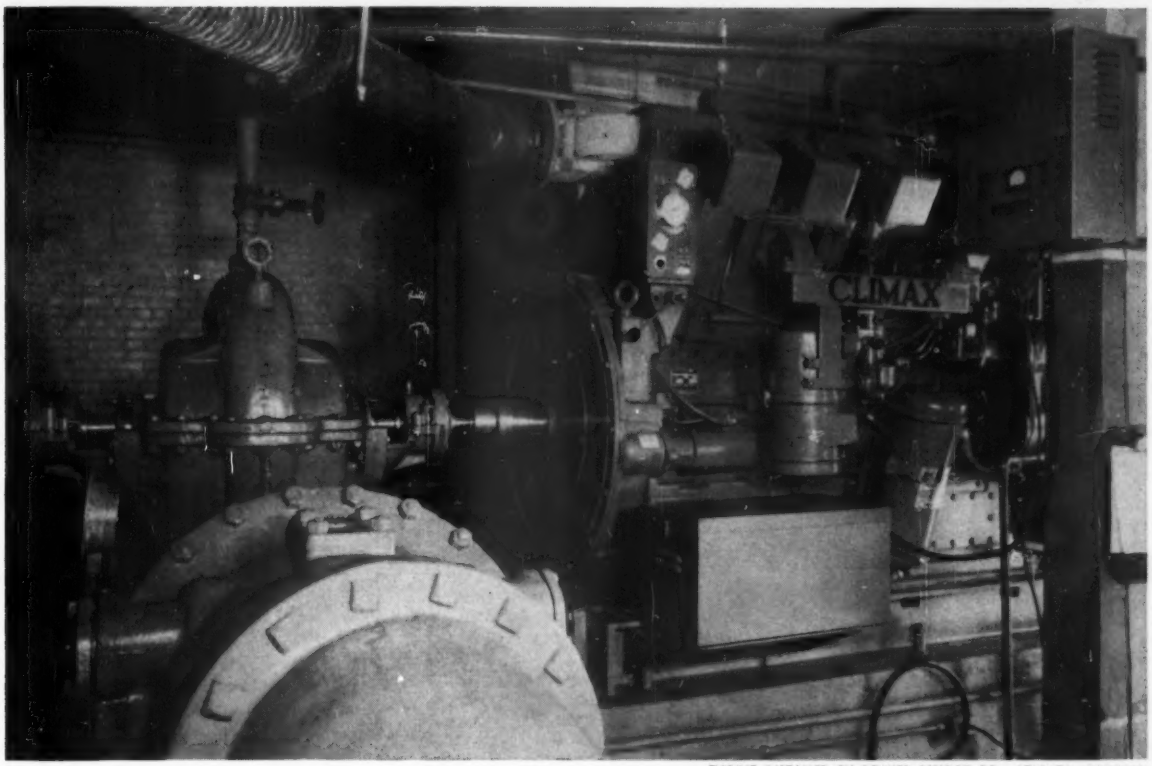
"Buildings more than 13 stories or 160 feet in height shall have a complete moment resisting space frame capable of resisting not less than 25 percent of the required seismic load for the structure as a whole. The frame shall be made of ductile material or a ductile combination of materials. The necessary ductility shall be considered to be provided by a steel frame with moment resistant connections or by other systems proven by tests and studies to provide equivalent energy absorption."

In support of the modification of Section (j), PCA is proceeding with a constructive program. The Association proposes to make available to the structural engineering profession technical information on the design of multistory reinforced concrete buildings for earthquake motions. These data would facilitate the design of structures that not only will meet code requirements and the recommendations of the Committee, but that also will survive moderate earthquakes essentially undamaged and the most severe probable earthquake without collapse, loss of life, or extreme property damage. The program, actually under way since the first of the year, includes five phases:

¶ Retain structural engineer-experts in seismic design as consultants on a research program and preparation of a design manual.

¶ Study available research data relative to the behavior of rein-

in an emergency...



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forced concrete structures and details under dynamic loading.

¶ Conduct theoretical studies and physical research in the PCA laboratories and in university laboratories of the ductility and energy absorption capacity of reinforced concrete frames; investigate details of reinforcement at column-girder connections to insure development of theoretical strength of members subject to reversal of stress in shear, bond, and anchorage, as well as flexure, and combined bending and axial load beyond the normal range of stress and deformation.

¶ Prepare and publish a comprehensive manual on the design, detailing, construction, and inspection of multistory reinforced concrete buildings subject to earthquake motions, and to issue interim information as it becomes available.

¶ Conduct a series of education courses by competent structural engineers on the subject matter of the manual and such other subjects as may be considered pertinent.

It was pointed out by Corning that over the years PCA had conducted considerable physical research on the behavior of concrete structures during earthquakes and recently more research concerning the ability of structures to resist blast forces. This material contains sufficient information on which to base the preparation of a design manual. The manual as now in progress will have six chapters, covering these topics: earthquake ground motion and its effects; basic principles of earthquake resistance design; discussion of design specifications and philosophy; behavior of reinforced concrete members; design of reinforced concrete members; and procedures for construction and inspection.

Blume explained that the PCA program is being approached carefully and objectively, in the belief that it will contribute not only to the improved use of reinforced concrete for seismic resistance, but also to improvement in concrete

3 NEW G-E MOTORS AND 42 QUALITY IMPROVEMENTS

A family appearance in power station motors and 42 basic design improvements are now available from General Electric. The three new enclosures shown here enable electric utilities to select power station motors with the same modern appearance. And all of these new motors contain the same advanced features, painstakingly engineered to meet electric utility standards of reliability.

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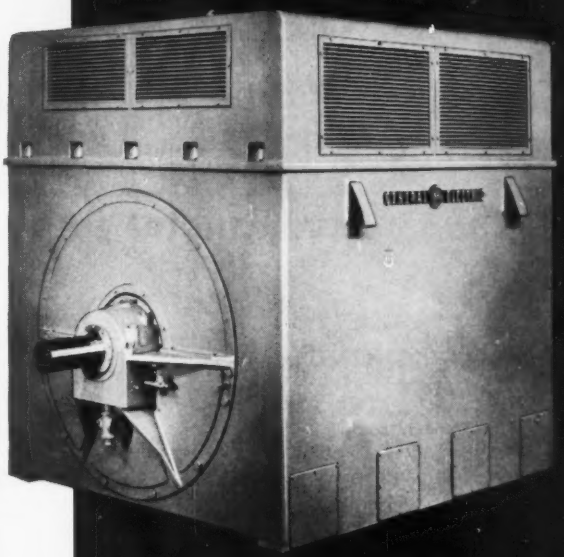

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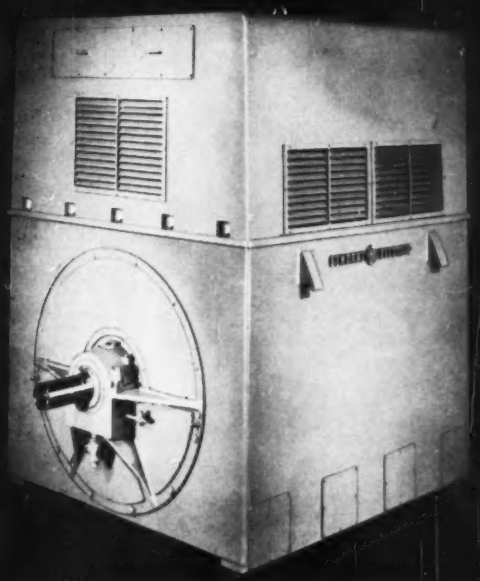

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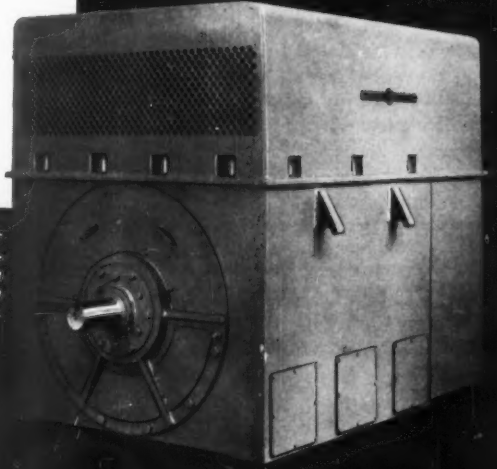

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and seismic design in general. He commented that reinforced concrete, unlike plain concrete, can be ductile, can absorb energy, and can have a storehouse of resistance. One of the basic problems of the program will be to assign reliable values to these properties.

Pointing out the practical aspects of his portion of the PCA program, Blume said, "We structural engineers have to keep a constant watch on the time and money required to design and to construct buildings and other structures . . . What is needed for the most effective and practical utilization of reinforced concrete for earthquake resistance . . . is a better general knowledge and appreciation of earthquake phenomena and of how the composite material (reinforced concrete) reacts all the way to failure."

Drift Problems

Separate papers on drift were presented by three consulting structural engineers: Henry J. Degenkolb, of San Francisco; Roy G. Johnston, of Los Angeles; and James Ruderman, of New York City. Degenkolb noted that in his calculations for drift he was concerned with wind forces only, that a major earthquake will move the structure regardless of the design. He further commented that the drift or deflection of a building will reflect the honest engineering that went into the design. Degenkolb pointed out that occupants do not feel deflection, only sway or drift, and that the psychology in this field has not been investigated thoroughly. He concluded by saying that he opposes drift limitations in building codes as tending to limit design.

Johnston opened his talk on drift by quoting from the Los Angeles City ordinance, "Lateral deflection or drift, of a story relative to its adjacent stories, shall be considered in accordance with accepted good engineering practice." The structural engineer thus is cautioned to exercise proper judgment

but is not required by law to conform to detailed and specified criteria. Johnson commented that to attempt to legislate against plaster cracks, or to try to prevent all nonstructural damage and any personal folly in a chaotic earthquake, is impossible.

Summing up, Johnston said: lateral deflection control is varied, complex, and must suit the pattern of the structure and the economics of the problem; drift limitation should depend on whether the nonstructural elements are rigidly anchored, flexibly attached, floated free, or permitted to crack; degree of drift limitation should be consistent with the forces involved, for example, the maximum recorded wind load in Los Angeles of approximately 65 mph is far different than the hurricane velocities of the eastern seaboard; and separation between buildings, although not directly related to the problem, should be great enough to permit a maximum lateral movement of the structure.

Ruderman stressed the importance of avoiding discomfort to occupants by minimizing the sensation of sway caused by wind. This disturbing effect is not produced only, or even principally, by wind magnitude. Steady pressure causing deflections of even large magnitudes will cause no perceptible sensation to the occupants. It is the sudden release of this potential energy between gusts or the change in velocity or direction of the wind that can cause disturbing sway. The amplitude is not as significant as the velocity of motion. It thus is related to the period of vibration of the structure.

Ruderman noted that in the last two decades a new uncertainty has been introduced. The buildings differ in many basic respects. Masonry walls often are replaced by metal and glass "skin," lessening rigidity and mass, and in New York the tendency has been to reduce floor to floor height and still provide for duct distribution, resulting in shal-

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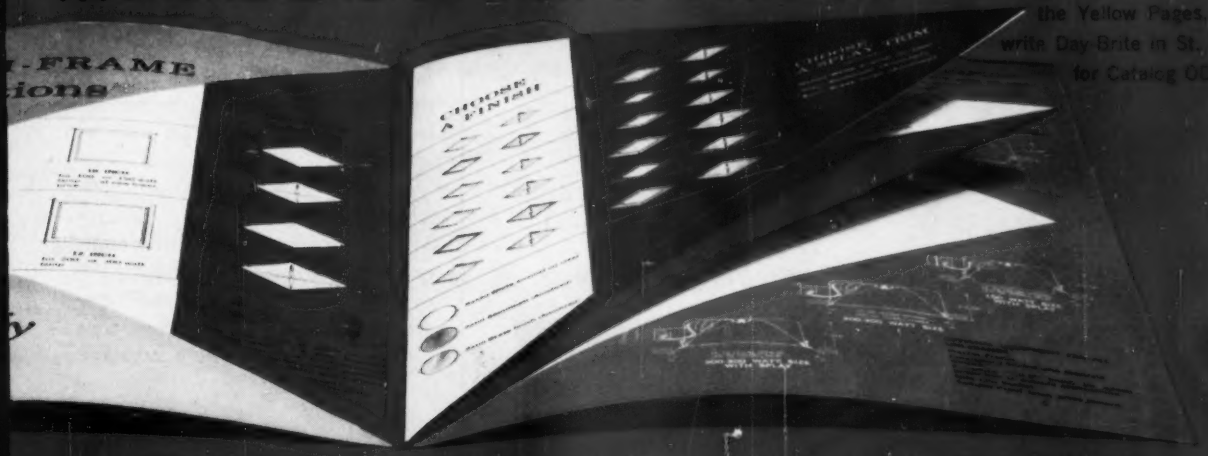

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low beam depth. The steel frame, assisted by little more than the floor construction and core partition, now must take all of the lateral force and deflect accordingly so that a casual acceptance of previous data may lead to unpleasant results. Ruderman also discussed design approaches adapted to present methods of construction.

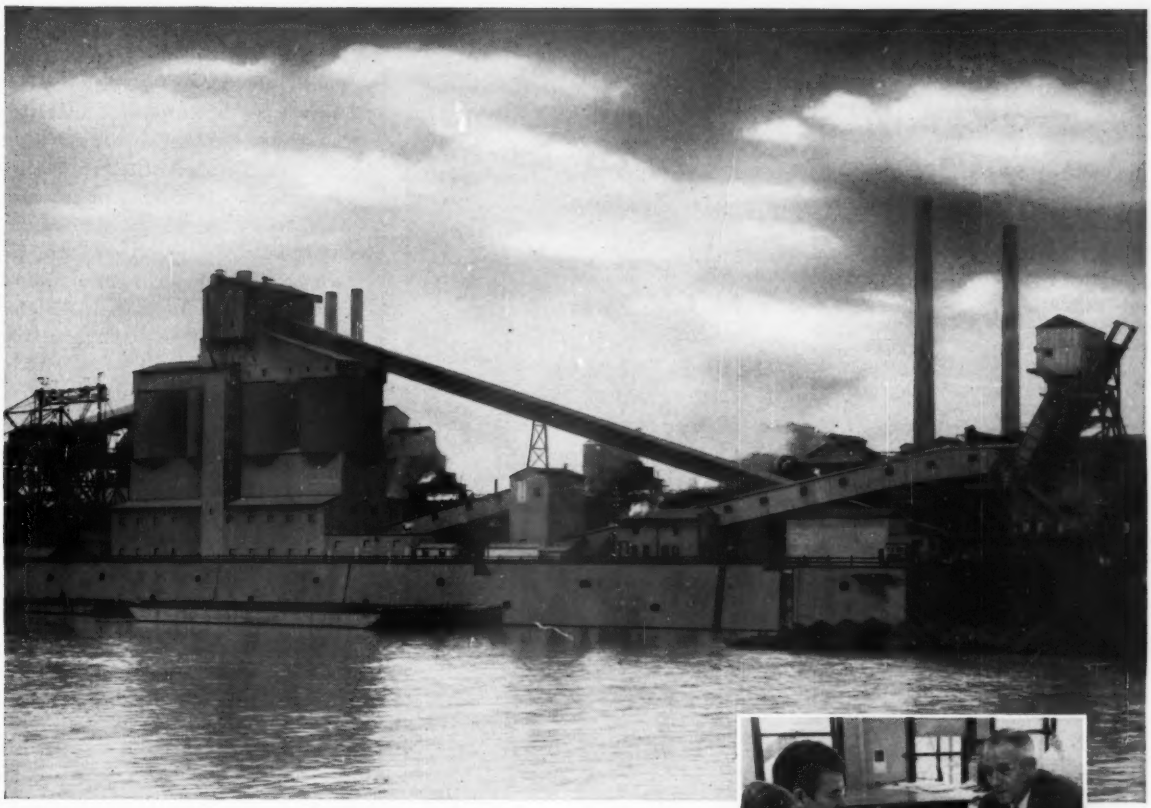
Steel Construction

N. W. Beattie, president of SEACC, introduced Edward R. Estes, AISC, at the second technical session. Estes said that AISC recently has cooperated jointly on research programs, bringing a broader range of viewpoints and experiences into the planning and supervision of projects. Participants follow the progress of the study closely, and findings are put in use much more quickly. Among the projects discussed by Estes were design and use of bolts and rivets and a newly developed theory for predicting ultimate strength of plate girders.

A paper on "Dynamic Testing of Structural Members," by J. R. Allgood and Warren A. Shaw, U.S. Naval Civil Engineering Research and Evaluation Laboratory, was delivered by Allgood. He stated that dynamic testing of structural members is required to verify or refute the judgment and assumptions upon which a theory is based. Structural dynamics are especially important since the advent of the nuclear bomb. Allgood explained the action of a blast simulator that has been developed recently for the Navy. This device enables the dynamic or static loading of full scale structural components under laboratory conditions. Total loads up to 260,000 pounds, corresponding to pressures of 185 psi may be applied in 0.001 of a second.

Folded Plate Design

Milo S. Ketchum, consulting engineer, of Denver, Colorado, spoke on "Folded Plate Design and Construction." Ketchum believes that folded plates have the advantage



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over other shell structures in that they can be analyzed with considerable precision by using the ordinary tools of structural analysis. He commented that this is not true of most other shell structures. The calculations for folded plates are concerned with the interaction of only a few plates and conform to the beam formula. He gave a simplified picture of folded plate analysis, and also described in detail several recently constructed structures using this particular form of roof construction.

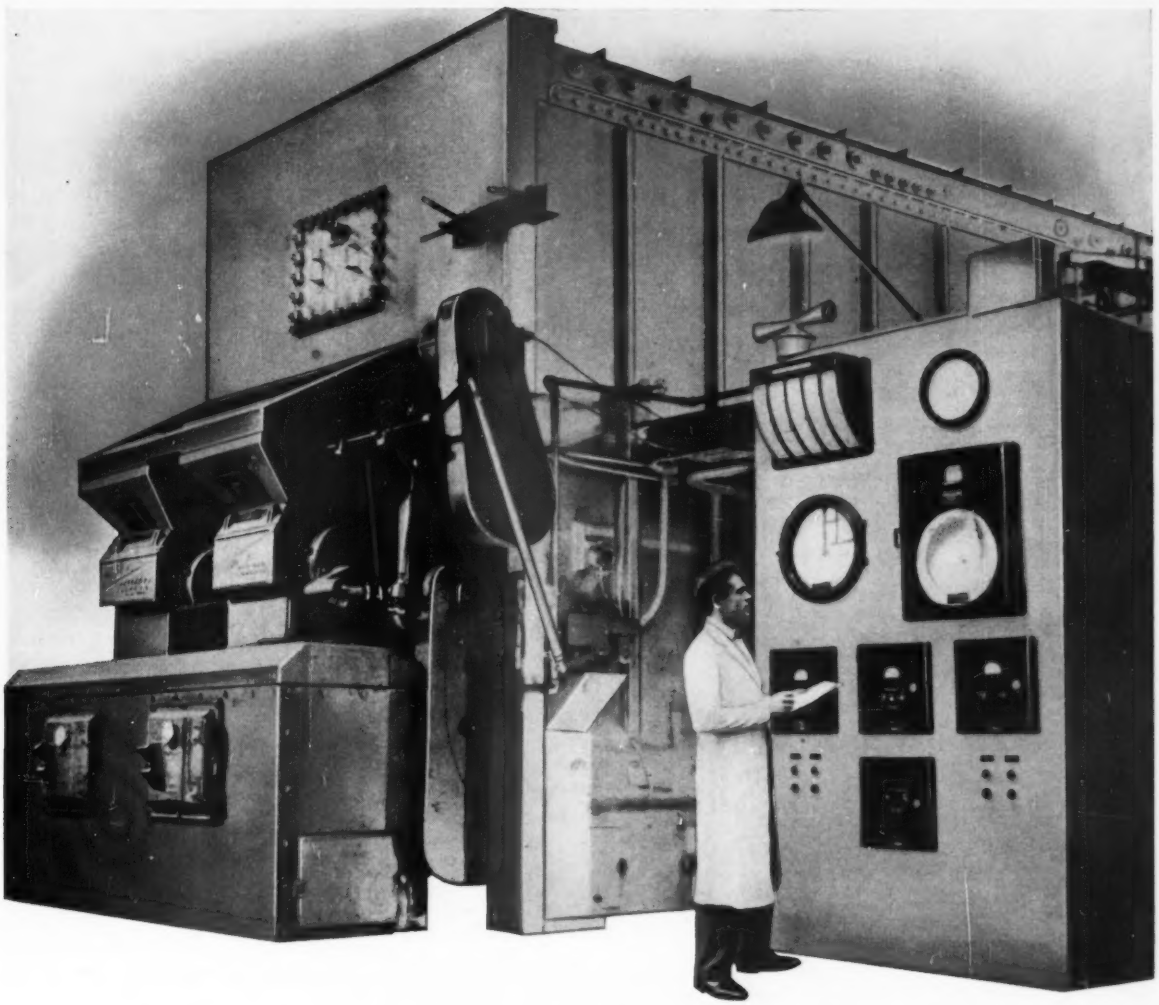
Rivet Fasteners

Walter S. Hyler, of the Huck Manufacturing Co., Detroit, Michigan, demonstrated Huckbolt fasteners and outlined their development. The Huckbolt fastener, marketed for many years in sizes from 5/32″ to 3/8″ diam., now is available in 5/8″ and 3/4″ diam. Hyler's remarks were concerned with the larger sizes and their application to the construction industry as a rivet replacement. He demonstrated the principles that make the Huckbolt a permanent fastener and concluded his remarks by saying that allowable design stresses for hot driven rivets also can be used for this fastener.

Panel Highlights the Practical

Harold Omsted, president of SEASC presided at the final technical session. A panel, consisting of Mark Falk, San Francisco, chairman; James L. Stratta, San Francisco; M. J. Heller, Sacramento; Allen H. Brownfield, Sacramento; and S. B. Barnes, Los Angeles, conducted a session on "Practical Lessons Learned Through Structural Design and Construction. Chairman Falk in his introduction commented that this was a first in SEA convention history in that "most of the remarks are going to call attention to unhappy experiences someone else has had."

Brownfield opened the discussion, illustrating his subject, "Shrinkage of Prestressed Lift



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Slabs," with slides. He described the California State Division of Architecture's first lift slab experience at Vacaville, California, in 1954. Due to symmetry and good perimeter connections at the walls, no perceptible shrinkage occurred and the Division proceeded with several other designs. However, in February 1957, C. M. Herd approved a shrinkage testing program. Brownfield then detailed the results of this program. No safety problems were found, but positive methods to avoid noticeable cracking were developed.

Barnes spoke of insurance investigations in cases involving responsibility of engineers and architects for construction failures.

LeRoy Crandall, Los Angeles, read a paper, by Harry W. Bolin, Ventura, on cracking and curling of ground poured concrete slabs. The material covered methods to prevent such occurrences.

Stratta spoke on "Failures of Timber Trusses." He named several occasions where unsatisfactory glued laminated beams were delivered to the job site and gave his conclusion that an independent testing laboratory should be used wherever glued laminated members are used. Stratta said that wood truss failure could be caused by use of timber with overly high moisture content, use of timber with twisted grain or containing a heart center, and imperfect alignment of holes in metal side plates and holes in the wood.

Jack Fratt, Los Angeles, spoke on parking deck and concrete waffle slab construction. He illustrated his talk with slides showing methods for repairing cracks. Fratt believes that inadequate field inspection by the engineer is a contributing cause in failures.

J. F. Meehan, structural engineer, of Sacramento, reported to the structural engineers on the California State Division of Architecture public fund aid in structural research. This program is intended to develop information in

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- Threads smoothly, cleanly
- Sound joints, welded or coupled
- Grades, finishes for all purposes
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the fields of materials, designs, and construction which would be in the best interests of the State with regard to public schools, and further, which is of such general nature as to be overlooked by industry research or other research organizations. Meehan said that the investigations have included wood diaphragms, wood construction, masonry, prestressed concrete, and earthquake effects on buildings.

New Officers

Officers elected for 1960 are: president, J. Albert Paquette, of Paquette and Maurer, San Francisco; vice president, Harold Omstead, chief structural engineer, Board of Education, Los Angeles; and secretary-treasurer, Harold S. Kelam, Pregnoff and Matheu, San Francisco. Directors include the officers and Herman Finch, Norval W. Beattie, Charles DeMaria, Marvin A. Larson, Joseph Sheffet (immediate past president), William A. Jensen, and Robert M. Wilder.

Appoint Committee Head

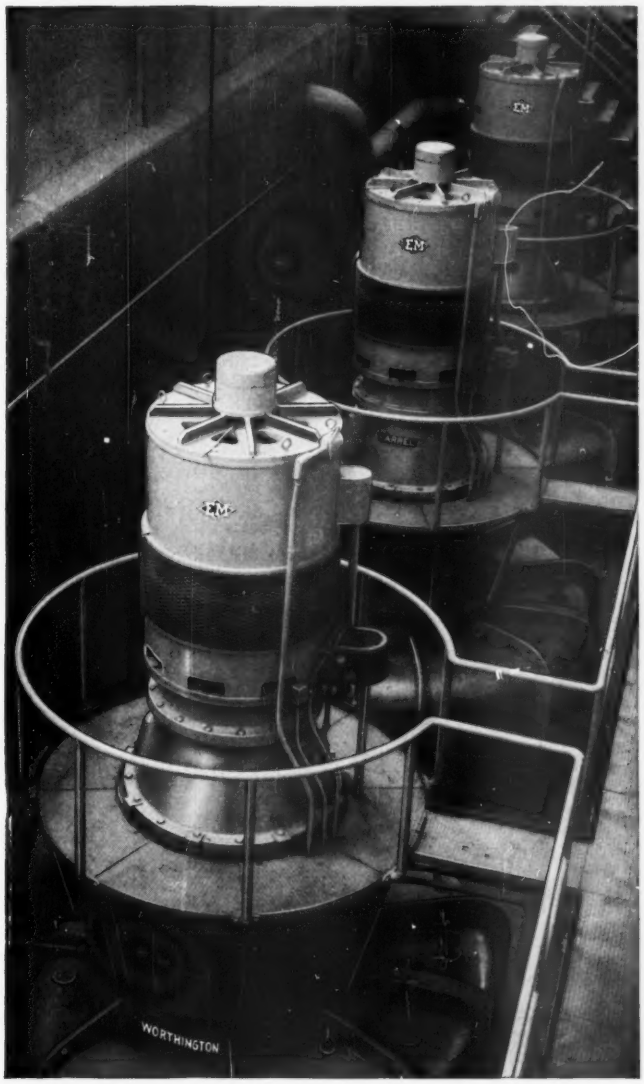
The California Legislative Council of Professional Engineers has appointed Leroy Greene, representing ASCE, Sacramento section, as chairman of a Liaison Committee to expedite information on bills. This committee was set up because of the problems arising from a new method of submitting bills over a longer period in the legislature.

Arizona Meeting

The semiannual meeting of the Arizona Consulting Engineers Association was held in Phoenix on October 13. James E. Hastain, president, outlined the accomplishments of the association during the past year and the objectives for the coming year.

Ralph M. Westcott, of Holladay and Westcott, Los Angeles, and president of CEC, described the activities of the Council. John H. Stufflebean, member of the NSPE Functional Section for Engineers in Private Practice and national

Sewage Pump Well Elevation Held at 114.5′±3″ Despite Big Variations in Flow



Three of four E-M 200 hp, 1200 rpm Vertical Synchronous Motors with Adjustable-Speed Magnetic Drives at Nut Island Sewage Treatment Plant of the South Metropolitan Sewage System in Quincy, Massachusetts.

E-M Vertical Synchronous Motor and Magnetic Drive Unit for adjustable-speed power transmission to vertical centrifugal pump. The ring element (1) mounted directly on the motor shaft turns at motor speed. The magnet element (2), mounted inside the ring element, has no mechanical connection to the motor . . . torque is transmitted through magnetic flux linkage between ring and magnet. By varying amount of excitation to magnet, pump speed can be precisely controlled.

AMAZINGLY PRECISE CONTROL OF SEWAGE PUMPS OBTAINED WITH E-M ADJUSTABLE-SPEED MAGNETIC DRIVES

One of the critical problems in operating Boston's new Nut Island Sewage Treatment Plant is complete control over the wide daily, weekly or seasonal flow variations. For example, flows may vary from 63 mgd to 249 mgd, with peak loads of nearly 300 mgd during stormy periods.

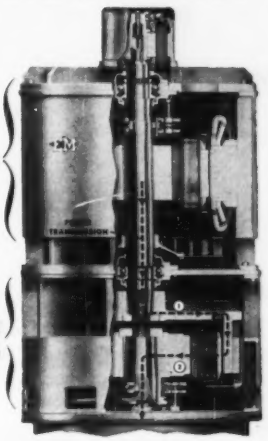
The pump well has to maintain an elevation of 114.5 feet with not more than 3 inches variation, to assure proper levels and flow velocities in the sewage processing channels. Control of the output of the low-lift sewage pumps has to be fast and remarkably accurate.

Use of E-M Adjustable-Speed Magnetic Drives for the low-lift pumps provides the sensitive speed control necessary in maintaining this close command of the pump well elevation.

Pump speed changes are dictated by a well float that actuates the Magnetic Drive through an E-M "Regutron" Control. Pump speed is automatically increased or decreased to maintain precisely the required pump well elevation. The Magnetic Drives are highly important and effective factors in most efficient operation of the Nut Island Sewage Treatment Plant for eliminating pollution in Boston Harbor.

For more information, see your nearest E-M sales engineer. And write direct for a copy of E-M Synchronizer No. 38 which tells the complete story of this outstanding installation.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA



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Specialists in making motors do
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director for the Arizona Society of Professional Engineers, also was present to answer pertinent question regarding the functional section's current activities.

SEAO Elects Officers

At a recent meeting of the Structural Engineers Association of Oregon, the following officers and directors were elected for the 1959-60 term: president, James D. Caufield, Caufield and Caufield, consulting engineers, Portland; vice president, Lloyd A. Pajuneu, Ross Island Sand and Gravel Co.; secretary-treasurer, Robert R. Adams, Cornell, Howland, Hayes and Merryfield, consulting engineers, Corvalis, Oregon; directors, Irving E. Olsen, Dames and Moore and Dick W. Ebeling, Cooper and Rosé, consulting engineers. Carryover members of the board are: Arthur M. James, consulting engineer, past president and Miles Able, of Hayslip, Tuft, Hewlett and Jamison, architects.

R. Evan Kennedy, consulting engineer with Edmundson and Kochendoerfer architects, is general chairman for the 4th Northwest Structural Engineers Conference to be held in Portland, on March 18-19, 1960.

CEAO Activities

The Consulting Engineers Association of Oregon included wives in the October meeting, first under the new officers' regime. A. Reid Chappell, of the engineering department of the Sheraton Hotel chain, discussed the problems of the hotel design field and its demand on the consulting engineer. The meeting, which was held in the new multi-million dollar Portland Sheraton, included a conducted tour of the hotel's facilities.

President Guy H. Taylor announced that James C. Howland, of Cornell, Howland, Hayes and Merryfield, of Corvallis, has been named chairman of the newly-created Public Disaster Committee of CEAO. ▲▲

Colorado rolls out 964 miles of Interstate Roads

Looking north on Broadway toward downtown Denver on skyline. Elevated section of new Valley Highway crosses center of picture.

Additional pictures on following pages..

Section of structural steel elevated highway in Denver, connecting north-south Interstate Road with road planned from Denver into Utah. This road to the west crosses the rugged Rockies, requiring an exceptional number of bridges.

In busy Denver area, steel bridge construction provides maximum clearance on short span. Tubular light poles, bridge rails, and sign supports of hot-dipped galvanized steel provide long, maintenance-free service.

Colorado is building 964 miles of Interstate Roads

Workmen assemble steel girders on new 150-foot bridge near Pueblo where railroad crosses U.S. 85-87.

KEEP OUR ROADS ON THE GO

At Colorado Springs, this 393-foot bridge provides quick routing for four lanes of traffic through town on U.S. 85 and 87. Steel reinforcing bars in these tapered piers assure the extra strength needed in this construction.

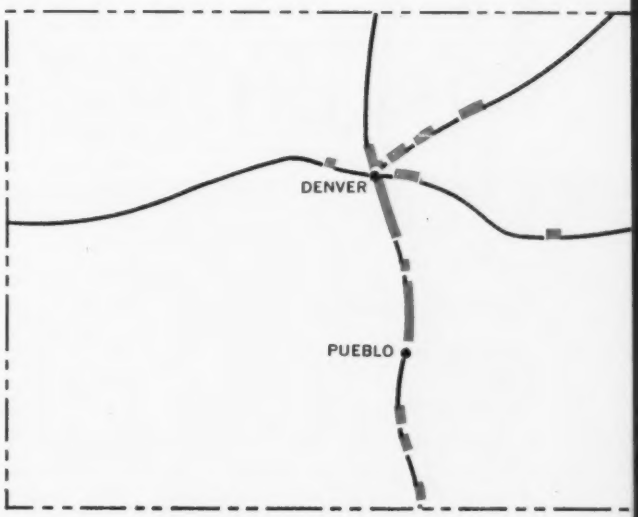
Colorado's highway engineers devised this efficient non-stop slip-form paver. In one continuous operation, it raises pre-joined strip of welded steel wire fabric to desired height, pours concrete through fabric and over it, levels the surface, forms a perfect edge with the moving edge-guide, and leaves behind an almost completed concrete highway.

with help of USS Highway Products

An impressive sight in Colorado these days is the explosive growth of first-rate roads. The Interstate Highway Program is in full swing. $324,300,000 in federal and state funds is being spent to construct 964 miles of new Interstate Highways and 5,200 new bridges. Already, more than 163 miles have been completed at a cost of about $20,700,000. The 8,433 miles of older roads in Colorado will receive a $2 billion modernization. Plans for the entire program are based on an expected 1975 traffic volume of 6½ million vehicles—over 3 times greater than present loads. This work is under the direction of Joseph J. Marsh, Chairman, Colorado Highway Commission, and Mark U. Watrous, Chief Highway Engineer.

United States Steel makes a complete line of highway products: Structural carbon steel, high-strength and constructional alloy steels for bridges; steel H-piles, sheet piling and tubular piles for bridge foundations; drainage products; cements for all types of concrete construction; slag, reinforcing bars and welded wire fabric; wire rope, cable, tubing and special steels for construction equipment; fence; beam and cable guard-rail, steel for signs . . . and dozens more.

USS is a registered trademark



USS United States Steel

Write for the *free* 54-page booklet, "Keep Our Roads On the Go." You'll find all the United States Steel products and services that will help you cut costs and speed operations in highway construction. United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

The highway market is served by the following divisions of United States Steel; American Bridge Division, Pittsburgh, Pa.; American Steel & Wire Division and Cyclone Fence Dept., Cleveland, Ohio; Columbia-Geneva Steel Division, San Francisco, Calif.; Consolidated Western Steel Division, Los Angeles, Calif.; National Tube Division, Pittsburgh, Pa.; Tennessee Coal & Iron Division, Fairfield, Ala.; Universal Atlas Cement Division, New York; United States Steel Supply Division, Steel Service Centers, Chicago, Illinois.

Heard Around Headquarters

THE American Society of Civil Engineers wrote its first Code of Ethics in 1914. Almost immediately its high purpose was frustrated by misinterpretation. This also has been true of all subsequent codes.

At its recent annual meeting in Washington, D.C., ASCE began a new effort to blow away the fog surrounding many sections of the current Code, and a report by the special task committee on interpretation was accepted.

According to the annual report, ASCE also is considering a further revision or expansion of the Code with the idea of producing a manual that would contain statements of interpretation and amplification of the principles involved. This manual also will carry case histories of professional conduct and clarify the application of the Code to employee engineers. Pertinent parts of the report submitted by the special task committee on interpretation will be incorporated.

As the introduction to the task committee report explains, "It (the Code of Ethics) is not merely a set of rules of right and wrong but rather an expression of that refinement of character which results from habitually ethical conduct in professional matters. However, questions sometimes arise with respect to specific ethical problems . . . In general it should be the practice of all engineers, where there is a question as to whether or not a certain procedure is ethical, to follow the course which is clearly within the limits of sound ethical practice."

Client Relations

In regard to the civil engineer's "first commandment," (client relationship) it is considered against the rules for an engineer to:

¶ Accept compensation from any source other than his client or employer, unless with the full knowledge and the consent of his client or employer.

¶ Accept or pay compensation for services not rendered

¶ Represent a client where there is conflict of interest involved without fully advising the client of such conflict of interest before accepting employment.

¶ Misrepresent qualifications to client or employers

¶ Give professional advice or testimony which does not reflect the engineer's best professional experience and judgment.

When is an engineer attempting "to supplant another engineer after definite steps have been taken toward his employment?" According to the task committee report, an engineer shall not continue to

The Seats are the SECRET!

W-K-M's NEW *Pressure Sealing* GATE VALVE

ASA 150 lb. (275 cwp)
and ASA 300 lb. (720 cwp)

Approved for many services including:

air • gas • water • butane/propane • kerosene • alipathic alcohols • aliphatic hydrocarbons • animal and vegetable oils • crude oils • naphtha • glycerol • ethylene glycol.

Line Pressure Seals the

The seats — made of specially formulated rubber molded to a hardened steel insert — are the secret to the valve's tight sealing performance. As line pressure in the valve increases, these unique seats actually float with the pressure to seal tightest where the most pressure is exerted.

Important Safety Feature

Excessive body pressure caused by thermal expansion is automatically relieved. The upstream seat is forced away from the gate by the excess pressure, allowing it to bleed into the line.

Change Seats in Minutes—on the line

You can change seats in W-K-M's Pressure Sealing Gate Valve (2" through 12") in 15 to 30 minutes . . . *on the line.* The only tools needed are a wrench and a pair of pliers.

Full Bore, Through-Conduit

Full bore, through-conduit gate construction permits a smooth flow with no more turbulence or pressure drop than through an equal length of pipe. The seats are fully protected from abrasive action of the lading flow.

Available Now

This versatile valve is available at leading supply stores everywhere. It's designed for pressures up to 720 psi (cwp) and temperatures up to 250° F.

ANOTHER OUTSTANDING PRODUCT OF W-K-M's *Creative Engineering*

Write for Catalog 1200

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seek employment from a prospective client after he has been advised another engineer has been selected subject to approval of detailed arrangements; he cannot seek employment from a client who already has engineers under contract for the same work not yet completed or fully paid for; and an engineer is forbidden to contact a prospective client after another engineer has made a study and report. In the latter situation, the engineer must wait for the client to come to him.

Competitive Bidding

The well known Article 4, regarding competitive bidding, is further clarified. "Solicitation of bids or proposals through the medium of public advertisement or any other notice that in essence is the same thing, or submission of bids or proposals in response thereto, would be a clear violation of the engineering Code of Ethics. Moreover, requests for, or submission of, proposals on forms prepared by a prospective client, where the only variable item regarding services to be rendered and the manner in which they will be carried out is that of fee, would undoubtedly indicate a situation in which price would be the contolling (sic) factor and which would not be altered by a statement that factors other than price will be considered. Under circumstances other than those just set out above, the client knows whether price will be the decisive consideration, and the engineer should make all reasonable effort to determine the basis upon which the selection will be made."

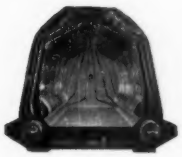
Originally, Article 4 said it was unethical "To participate in competitive bidding against his colleagues to secure a professional engagement which is to go to the lowest bidder." Then in 1949, it was changed to state that it was unethical "To participate in competitive bidding on a price basis to secure a professional engagement." In 1956, it became unethical "To invite proposals for the performance of engineering services or to state a price for such services in response to any such invitation, when there are reasonable grounds for belief that price will be the prime consideration in the selection of the engineer."

Dissatisfaction Noted

Apparently it still is a problem, for according to the report, "Opinions have been expressed that adoption of the present wording represented a relaxation of the Code. This thought seems to be due to the use of the words, 'reasonable grounds for belief, etc.' Certainly there is no justification for anyone not knowing what these words mean, and also it was definitely the intention of the several Boards of Directors and Society Committees to strengthen rather than relax this part of the Code. The records of the Society since

Now... A FULLY PACKAGED WATER-TUBE BOILER

designed for capacities from 4,000 to 21,000 lbs./hr.

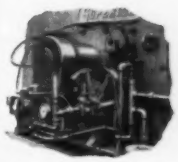


LARGE FURNACE

provides ample space for efficient combustion and maximum heat absorption. Refractory-covered air-cooled floor provides preheated air for combustion.

TANGENT TUBE WATER WALLS

formed of 2" tubes without fins, provide adequate radiant surface to insure instant response to steam demands, as well as capacity operation without straining.



FULLY AUTOMATIC OPERATION

Superior Rotary Burners designed for this boiler require no steam or compressed air for starting. They combine maximum safety with minimum supervision.

REAR-MOUNTED DRAFT FAN

results in unusually quiet operation, adds the advantages of an air-cooled furnace floor and pre-heated combustion air to an uncluttered firing front.

AIR-COOLED OBSERVATION PORT

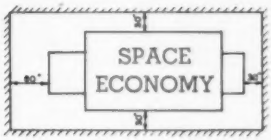
permits viewing the entire furnace under operating conditions without obstructions. This feature invites frequent inspection and efficient operation.

INTEGRATED CONTROLS

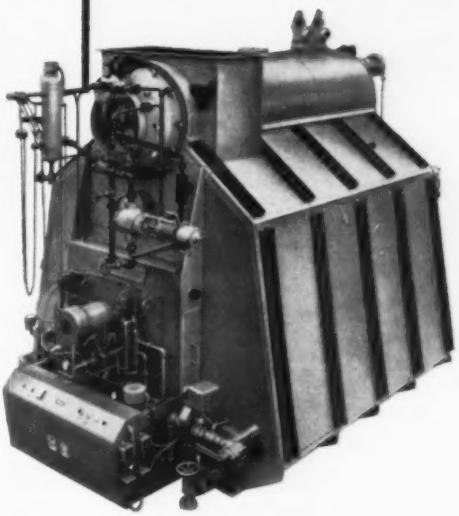
Carefully engineered to provide maximum safety and highest combustion efficiency, all controls are complete factory-installed and factory-fire-tested.

ROTARY VALVE-IN-HEAD SOOT BLOWERS

Designed for use while the boiler is in operation, this "big boiler" feature avoids "down-time" for manual cleaning; maintains peak operating efficiencies.



Where economy of space is a factor, consider the *actual* space needed. This boiler requires minimum tube removal space . . . a big boiler in a small package.



Designed to provide for industry the quality features so long associated only with big water tube boilers, the Superior Type AS Packaged Boiler brings to its capacity range (4,000 to 21,000 lbs./hr.) a new standard of boiler performance. Features are integrated for production of dry steam, sustained efficiencies, and maximum safety.

Completely factory-assembled and factory-fire-tested before shipment, it is backed by a written guarantee of performance and the undivided responsibility of its maker.

For complete details write for Catalog 13AS.

type AS

Specialists in PACKAGED BOILERS... exclusively

SUPERIOR COMBUSTION INDUSTRIES, INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.

SUPERIOR
PACKAGED BOILERS

adoption of the present wording sustain this intention."

Professional Advertising

When is advertising self-laudatory or derogatory to the dignity of the profession? "Dignified statements, with or without illustrations, may be made regarding the professional activities of an engineer or an engineering firm for presentation to potential clients in the form of a brochure including factual information concerning experience of the firm and its key personnel.

"It is also proper for the names of consulting engineers or engineering firms to be included in a professional directory of technical or allied periodicals, provided they conform in size and character to similar listings of other professional engineers listed therein.

"The insertion of display advertising in any media, offering engineering services either alone or in conjunction with advertising of construction or contracting activities, is not in accord with proper ethical procedure."

Moonlighting

What about the use of the advantages of a salaried position to compete unfairly with engineers in private practice? (Commonly called moonlighting). "This article is not intended to infer that salaried engineers such as professors, for example, cannot ethically do outside consulting work. It is recognized that such work should better qualify the individual for the teaching profession and can be ethically done, provided the fees charged are equal to those charged by consultants in the same field and operating in the same area, and further provided that their consulting work is not prejudicial to their salaried position and has the approval of their employer. Within the limitations of the above provisions, other salaried employees may also ethically do outside work."

How to Get a Client

How can a consulting engineer get a client? Here the engineer is given only negative advice. He cannot:

¶ Engage attorneys, men of influence, or outside professional contact men to aid in securing employment from a client

¶ Make political contributions that may influence the selection of engineers on future work

¶ Solicit engineering work through other than members of the engineer's own organization

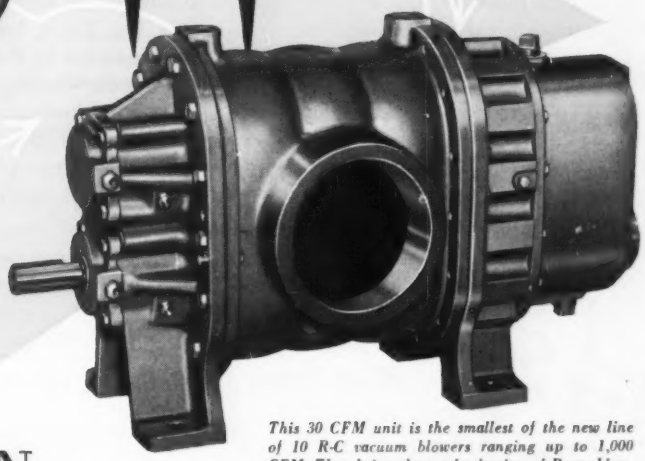
¶ Create an obligation on the part of prospective clients through extravagant entertainment, gifts, or similar expenditures.

¶ Engage in fee splitting or other distribution of fees for other than services performed and in proportion to the value of such services

¶ Solicit or accept an engineering engagement, or submit a proposal or contract covering engineering services involving the economic feasibility of any project when the

NOW

for efficient vacuum service as low as 30 CFM...



This 30 CFM unit is the smallest of the new line of 10 R-C vacuum blowers ranging up to 1,000 CFM. They bring the total selection of Roots blowers to 46 sizes...with savings for you in every size.

A BIG SELECTION OF SMALL ROOTS VACUUM BLOWERS

Roots-Connersville adds 10 small-volume vacuum pumps to its already extensive line to give you better selection, better performance in limited-volume applications. This new line is designed to handle capacities ranging from 30 CFM to 1,000 CFM, for operation at up to 20 inches mercury vacuum in single stage construction. These units are designed for compounding for higher vacuum service.

Major features of the larger Roots water-sealed units are retained: simple, efficient design without internal valves, no internal contact between moving parts, normal maintenance limited to oil changes, efficient operating speeds and minimum sealing water requirements. The result is more CFM per dollar.

Only Roots-Connersville offers exclusive rotary positive design and such ease of installation in vacuum blowers of this size. They are now available for a wide variety of application in the food, chemical, petroleum, paper, sewage and industrial waste treatment, mining and other industries.

Your nearest Roots-Connersville sales engineer has full details on this new series of vacuum blowers. Or write for a specification sheet and for Bulletin VP-158 covering the larger units.

ROOTS-CONNERSVILLE BLOWER
DIVISION OF DRESSER INDUSTRIES, INC.
1259 Wilson Ave., Connersville, Indiana. In Canada—629 Adelaide St., W., Toronto

fee for such services is contingent upon the report being favorable to such project

Perhaps a supplemental "positive" list would be appropriate.

Evaluation of the Code

How did the uninterpreted Code serve last year? Of 15 cases presented to the Professional Practices Committee, 12 were closed. Some of these were settled with a warning letter to the person concerned, some of the cases were unfounded. Three were carried over to this year; — one is awaiting a court ruling on the engineer involved.

This year, *Civil Engineering* magazine may be permitted to publish some of the ethics rulings if the accused engineer is found guilty. Publication in each case, however, will be decided upon by the Board before any information is submitted to the ASCE magazine. The data is to be given to no other publication, according to Executive Secretary William H. Wisely, because ASCE legally can circulate the stories only among the membership.

Soils Engineers Study Ethics

The soils foundations engineers also have decided they need some clearly defined rules in regards to ethics. Meeting at the National Society of Professional Engineers building during the convention, the soils consultants voted to ask ASCE either to establish a Committee on Ethical Practice within the Soil Mechanics and Foundations Division, or to set up a subcommittee pertaining to consulting soils and foundations engineers within the existing Committee on Professional Practice. The matter was duly referred to both committees.

According to a resolution prepared by the Texas Section of ASCE and adopted by the informal group during the Washington meeting: "If the performance of subsurface exploration, field tests, or laboratory tests is to include planning of the work, engineering supervision, selection of part or all of the test procedure, or interpretation of the results, the work is classified as a professional engineering service.

"If the performance of subsurface exploration, field tests, or laboratory tests is to be in accordance with published standard procedures or completely specified procedures, and if no engineering responsibility for adequacy of the procedures or for any interpretation of results is involved, the work is classified as a technical but subprofessional service which is ethically subject to competitive bidding."

As the soils consultants explained, the above statement was prepared by the Texas group because in the Southwest, "all inclusive services" are offered by soils engineers—thus creating a problem as to when a client can ethically call for competitive bids on soils work.

Status of Surveying

Some time ago, it was voted to include surveying as a part of civil engineering practice — thus making it unethical to offer or accept competitive bids for surveying work. This has led to complications, since many government agencies and private clients traditionally have asked for bids on surveying. The entire matter has been referred back to committee for further clarification, to be presented later to the executive committee.

ASCE also ruled at the Washington meeting that land or property surveying experience can be counted as professional experience on membership applications, but cannot be classified as "responsible charge of work." Engineering surveys, geodetic surveys, geodetic engineering, geodesy, cartographic surveying, cartographic engineering, or map and chart surveying, can be included as "responsible charge," for membership qualifications in the Society, by the engineer who is responsible for the success of the project (if it is large enough).

any way you look at it...

YARWAY REMOTE LIQUID LEVEL INDICATOR GIVES BRIGHT, INSTANT, ACCURATE READINGS

On its brilliant "wide vision" dial you can clearly read the level from any point in a 180° arc—and from a considerable distance.

Remote readings of levels in boilers, feed water heaters and other heat exchangers are instant and accurate because indicator operating mechanism is actuated by the varying head of the liquid itself, yet the pointer mechanism is never under pressure.

Yarway Indicators may be arranged to operate remote Yarway Electronic Secondary Indicators or remote Hi-Lo Alarm Signals (lights or horns) located anywhere in the plant.

A record of nearly 13,000 successful installations speaks for itself.

For details on construction, operation, installation and typical hook-ups, write for Yarway Bulletin RI-1825.

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YARWAY
A MARK OF QUALITY IN STEAM ENGINEERING

Preparing Accurate Budget Estimates

BUDGET ESTIMATE -- AIRFIELD CONSTRUCTION
(All unit prices include insurance, overhead, profit, and bond)

Item	Description	Quantity	Unit	Unit Price	Total Amount
	A. Relocation Work				
1.	Relocation of underground electric power lines:				
	a) Right-of-way acquisition	40	Acre	$ 2,000.00	$ 80,000
	b) Overhead relocation on wood poles	6,000	L.F.	50.00	300,000
2.	Relocation of 4-lane county road (asphaltic concrete)	2,000	L.F.	100.00	200,000
	B. New Runway and Taxiways				
3.	Land acquisition	160	Acre	1,500.00	240,000
4.	Clearing & grubbing	140	Acre	600.00	84,000
5.	Tree topping	Job	L.S.	----	20,000
6.	Common excavation	600,000	C.Y.	.80	480,000
7.	Rock excavation	150,000	C.Y.	2.50	375,000
8.	Surface drainage system:				
	a) 36" storm drain	11,000	L.F.	20.00	220,000
	b) 24" storm drain	5,400	L.F.	12.00	64,800
	c) Drainage structures	75	Each	750.00	56,250
9.	Subdrainage system:				
	a) 6" subdrains	30,000	L.F.	3.50	105,000
	b) Observation manholes	100	Each	300.00	30,000
10.	Two 4" underground electrical service ducts	4,500	L.F.	5.00	22,500
11.	Electrical manholes	8	Each	1,800.00	14,400
12.	Airfield pavement (asphaltic concrete), including base & subbase courses, complete:				
	a) Runway pavement	120,000	S.Y.	7.20	864,000
	b) Taxiway pavement	70,000	S.Y.	7.50	525,000
	c) Apron pavement	15,000	S.Y.	7.50	112,500
13.	Pavement painting	Job	L.S.	----	8,000
14.	Topsoiling & seeding	120	Acre	900.00	108,000
15.	Airfield lighting:				
	a) High intensity lights for the runway	110	Each	340.00	37,400
	b) Medium intensity lights for the taxiway	220	Each	240.00	52,800
	c) Lighting cable designed for direct burial	40,000	L.F.	.35	14,000
	d) Lighting transformer vault & equipment	Job	L.S.	----	20,000
	e) Connection to the existing electric power line	Job	L.S.	----	3,000
Subtotal, Items 1 through 15, inclusive					$4,036,650
Projected increase in construction cost to year 1962 (5%)					201,830
					$4,238,480
Contingencies, Engineering, Supervision of Construction, and Administrative Allowances (13%)					551,000
Total cost					$4,789,480
				Say	$4,800,000

Budget estimate is based on current prices, with future increases figured on lump sum.

HERBERT F. SHATZMAN, Supervising Engineer
Seelye Stevenson Value & Knecht

Herbert F. Shatzman received his B.C.E. from the College of the City of New York, in 1950, and shortly thereafter he joined the firm of Seelye Stevenson Value and Knecht as a structural designer. Later he devoted several years to field inspection and supervision of heavy construction before deciding to specialize in the field of cost estimates and contract specifications. Shatzman, now in responsible charge of the estimating and specifications department, has successfully estimated over $200 million worth of construction during the past six years and has written specifications for a wide range of projects including airports, industrial buildings, military installations, and other classified work. He is a licensed professional engineer in New York and member of the Construction Specifications Institute.

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THE SUCCESS of many a project depends upon the advance construction, or budget, estimate. Clients usually present a fairly accurate description of what they are interested in, and logically enough, they want to know the total cost of the project before they begin to consider details of the design.

If the actual bid is considerably in excess of the estimated budget amount, the client clearly has been misled. The situation becomes more acute if reserve funds are not available to cover the increased cost. As a result, measures must be taken to reduce the scope of the work, thereby initiating a series of time-consuming negotiations aimed at resolving the problems. In the event that a suitable agreement fails, the project may have to be readvertised or even abandoned. New construction of a worthwhile nature often has been needlessly postponed or deferred because unreasonably high and inaccurate budget estimates were submitted.

Conversely, if the actual bid amount is well below the budget estimate, the client may be satisfied, especially if he is assured that he has obtained a good price based upon an economical design. However, the project could have been underestimated in the beginning, thereby depriving the client of a larger or more complete job, especially since the client was willing to spend more money all along. In both instances, the resulting deficiency or excess in funds could have been detected through accurate cost soundings.

Team Requirements

Personnel experienced in the broad aspects of design and construction methods are essential for accurate budget estimating. Construction men and designers both have their shortcomings. Construction men are apt to overlook design criteria peculiar to the locality and type of installation. They are also likely to fail to take into account regulations of authorities having jurisdiction over the work.

Engineers principally experienced in design sometimes fail to consider savings available through special construction methods and special aspects of labor, material, and equipment conditions that are peculiar to the locality. Engineers also frequently fail to include savings resulting from planning of various work stages so as to permit a minimum disruption of construction operations.

While a few consulting firms maintain a permanent staff of graduate engineers specializing in all phases of cost estimating, this is the exception rather than the rule. Most consultants have to go outside and get the services of contractors, other engineers, public agencies, or cost consultants in order to assemble an accurate budget estimate.

Guard Against Errors

Clients seem to have a marked lack of patience regarding the preparation of budget estimates. Once they decide upon a project, they want to know the total cost, several comparative costs, and a few unit prices, all within a short period of time. The estimator is placed in the difficult position of working with very preliminary information, and within a strict time limitation. It is important, however, not to get excited because of the urgency of the situation, for this is a prime reason for errors and omissions. Important phases or sizeable portions of work can be omitted entirely, and there is a strong possibility that these errors can remain unnoticed until after a recommendation has been made, thus creating an embarrassing and difficult situation. Errors of this type are usually of the obvious variety as represented by:

¶ Estimating the cost of a multiple story building using an average unit price per square foot and neglecting to include an entire floor area or the basement area.

¶ Estimating quantities from half-plans (symmetrical about a common centerline) and forgetting to double the quantities.

¶ In a project involving heavy earthwork in which much excavation is to be stockpiled for subsequent use, the rehandling of this same material is not considered when computing the total quantity of excavation. This condition is also applicable to jobs where the foundation substrata is to be stabilized by means of earth surcharge and the surcharge is to be removed after a specified period.

¶ Failure to apply realistic shrinkage and compaction factors to common excavation and borrow; and a proper expansion factor to rock excavation.

Proper Procedures

A visit to the site of the proposed construction can be of infinite value to the estimator. He often is furnished with general descriptions and photographs of the proposed site, but an actual inspection can afford him a realistic grasp of the situation, which also can assist the designers in their planning work.

In order to account for all major items, divide the job into principal phases of work and subdivide each phase into as many convenient parts as may be necessary to work in familiar units. For example, subdivide a storm drainage system into such items as pipes of various diameter, manholes, inlets, headwalls, and special structures. It is wise to apply unit prices to as many basic quantities as can reasonably be obtained from the work. If, in the process, a so-called "project train of thought" can be created, the threat of serious omissions can be overcome, and the estimator also will be able to proceed with more confidence.

It is important also for the estimator to make special note of unusual conditions that might affect the cost of the work:

¶ Is there enough labor available in the area? If large projects are to be constructed in remote areas, labor may have to be obtained at a premium rate. On some jobs labor is so scarce for certain trades that a per diem subsistence allowance must be paid in addition to premium wages.

¶ Are there any impending labor disputes, such as major strikes, which would affect the anticipated completion date? In addition, certain key materials, such as cement, steel, and other metals, may become scarce. This situation might require a change in the basic design.

¶ Are any of the required materials of a critical nature, subject to government priority ratings?

¶ Is there any construction in the area at the present time? If so, what kind and of what magnitude?

After a study of these and other related conditions, unit prices can be assigned to each increment in each phase of the work. Only current unit prices should be used no matter how far off the proposed time of construction. An attempt to increase or decrease each unit price in order to compensate for possible future changes in construction cost almost always results in a loss of cost control because of the lack of a definite baseline. Instead, the completed estimate should be advanced to the anticipated future date by means of a cost index applied to the total amount. This will avoid the danger of an unbalanced estimate and will be more readily understood by reviewing agencies and clients. If the project is further deferred, the estimate can be readjusted by changing the over-all cost index.

The mathematics of the estimate should be checked carefully, for simple errors of arithmetic can crop up. A $100,000 error on a large project can be easily overlooked. It is advisable to check the mathematics twice. During the course of such a review, many pertinent facts completely unrelated to the mathematics of the estimate often are uncovered. It is at this point that the scope of the entire job assumes proper perspective.

A suitable amount for overhead and profit must be included if these factors have not been previously incorporated in the unit prices. Add a contingency factor, not for the purpose of covering deficiencies in unit prices but to compensate for incomplete information on the job conditions. The magnitude of the contingency factor will depend upon the degree of accuracy and completeness of the available information, and, consequently, the determination of the contingency factor will be governed by the judgment of the estimator. His decision should be made after careful consideration, since budget estimates are easily distorted as a result of excessively high contingency factors. The estimator should keep in mind his own natural tendency to fatten the contingency factor. Too low a contingency factor is a rare occurrence. The estimate also should indicate clearly whether consulting engineering services, including surveys, design, and supervision of construction have been included in the total cost.

Comparisons — and Pitfalls

The estimator must itemize all the unusual conditions relating to the project and try to compare the cost with nearly similar jobs for which definite costs are known and for which the corresponding special conditions also are known. Beware of the rule of thumb. A generally accepted estimate of unit cost becomes meaningless when applied to a job that is completely unrelated in size or scope. If an estimator is confronted with a project containing a host of special conditions, he must forget the rule of thumb and trust his judgment.

Personnel associated with the job — and other engineers and construction men having little or nothing to do with the job — will volunteer their opinion as to what unit prices and the total amount should be. There is always someone who will point out that two years ago, on a job in the same area, concrete pavement 9-in. thick was bid at $6.00 per square yard. This is contrasted with the $10.00 per square yard estimated for the current job. Upon further investigation the estimator may find a number of possible explanations based on the fact that the advisor does not remember whether a base or subbase course was included in the unit price. He also does not remember the quantity of concrete pavement or whether the concrete was transit mixed or was mixed in a plant set up at the job site. He has forgotten whether this was a rush job with labor premium for overtime. Rules of thumb, in other words, cannot possibly be made to apply to advance construction estimates where many uncertainties exist.

Summation Report and Records

Finally, the estimator must tabulate the estimated items in accordance with construction sequence, highlighting the descriptions of all costs relating to special design considerations. It is usually impractical to offer too many details; however, enough information should be presented to afford the client or reviewing agency a clear picture of the major items, quantities, and unit prices. It is wise to include items in which the client has indicated a particular interest such as perhaps relocation of existing facilities, demolition work, landscaping, or provisions for safety of the project.

As a basis for reference, it is advisable to maintain a complete, dated record of all supporting data and assumptions that were used to establish quantities and unit prices. Estimators have wasted too many hours searching for all sorts of information that was never properly recorded.

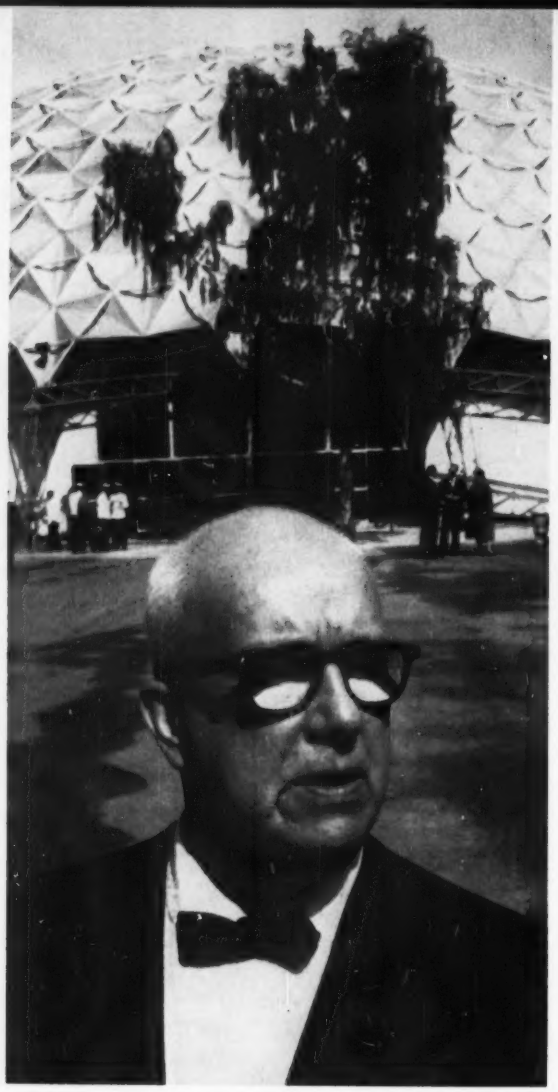
Much valuable information is currently available on the subject of preparing realistic engineering construction cost estimates. It is equally important to be able to prepare advance engineering construction cost estimates to guide clients through the early planning stages and to present a realistic figure to represent the ultimate cost of the work. Final estimates are of no consequence if sufficient funds are not available after months of planning and preparation of contract drawings and specifications. Accurate and alert cost control maintained throughout all planning stages can prove invaluable to clients and can do much to enhance the reputation of the consulting engineer. ▲▲

Alexander Memorial Center Georgia Inst. of Tech.

Dome Structures . . .

A Philosophy of Space and Shape... *R. Buckminster Fuller*
A Reconstruction—Contrast in Technologies
Engineering Aspects
Designs in Metal
Designs in Concrete
Designs in Wood and Other Materials

STAFF REPORT



Dome Structures...

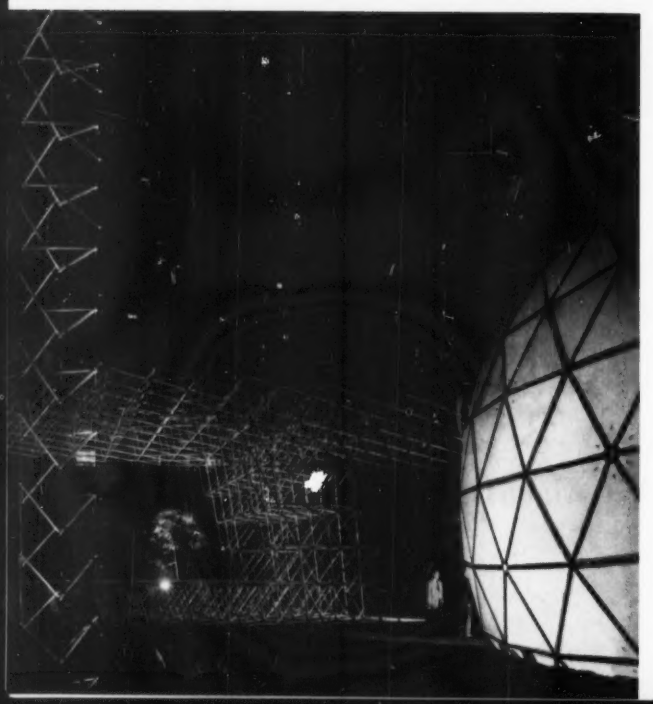
A Philosophy of Space and Shape

R. BUCKMINSTER FULLER

It was a big year for R. Buckminster Fuller. In Moscow, the Kaiser designed, gold anodized aluminum dome brought worldwide attention to the practical side of his geodesic geometry. In New York, a display of some of his unusual structures at the Museum of Modern Art gave status to the aesthetic aspects of his design concepts.

For Fuller, who stands somewhere in the no-man's-land between architecture and engineering, these honors had been a long time coming. In his 64 years he has seen most of the world, lectured at its greatest universities, and propounded his ideas on everything from automobiles to bathtubs. Yet his real goal has been to marshall the world's technology into a system that will provide more things for more people from fewer and fewer natural resources. Unfortunately, the wave of publicity that has followed each of his ventures into specific product areas has obscured this broader concept. His almost continuous concern with structural theory, for example, has manifested itself only in a rash of dome structures. Yet Fuller's domes are just the first shot in a one man uprising against conventional structural design.

In this article, written exclusively for CONSULTING ENGINEER, *Fuller discloses for the first time in print the theory underlying his geodesic structuring. He shows how his approach led to the discovery that, contrary to experience with conventional buildings, the geodesic structure gives an improved ratio of strength to weight as the volume enclosed is increased.*



DOMES MADE BY NATURE — caves or the vaulted branches of trees — have been used by man during his whole tenure on earth. Domes made by man have been used by man for hundreds of milleniums. From a common origin in the woven basket of antiquity, man-made domes divide into two opposite concepts of structuring. One reaches for the ephemeral grace of Geodesic Tensegrity. The other stagnates in the permanentized ugliness of conventional monumental structures.

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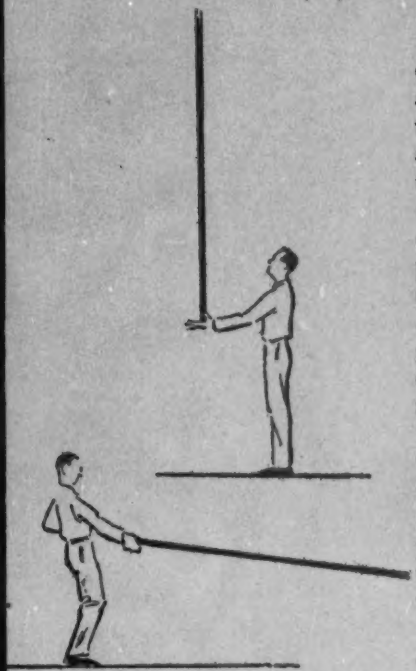
It is a good guess that nature suggested this permanentizing to man when snow and ice amalgamated accidently with his domical basketry of bent saplings, reeds, thatching grass, and skins. Recognizing the ice-augmented strength of this early equivalent to modern steel reinforced concrete, men ascribed the improvement in structuring to the ice component.

the early Aegean sailors' high-sea peregrinations inevitably took them into Arctic island hibernations in man-made caves formed by their overturned boats. Closing in their boat roofed caves with rocks and ice cakes, taught them the ice fashioning of domes.

Wedges or corks can be placed in oriented regularity so that the greater shoulders are always on one side and the smaller shoulders are on the other. A horizontal extension eventually describes a circle. A vertical extension of the pile curves upwardly and inwardly from the base circle, closing at an apex. The wider, outer shoulders of the individual wedges prevent any one wedge from slipping towards the center of the hemispheroidal pile-up. Save for the friction between the dome's base and the earth below it, and the friction between the upwardly and inwardly tiered wedge layers, there is nothing to keep any of the wedges from slipping or oozing outwardly.

this the early sailors knew instinctively. To understand man's subsequent arrival at later dome building strategies, we must consider many other factors which he differentiated intuitively, out of his hard won sailor's experiences. These experiences gradually generated a generalized structural wisdom in professional sea masters.



A man can support a long column, say a 15-ft wooden pole, in a vertical position on the palm of his hand. Thus positioned, gravity operates upon the pole only as a downward force, concentrated entirely within the neutral vertical axis of the pole. But an attempt to hold the same 15-ft pole horizontally with outstretched arm is extremely difficult, for the force acts through a point at a distance from the support and is moment magnified.

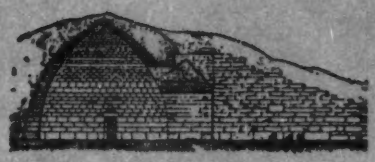
The vertical and horizontal pole experience of man leads to his sensitive understanding of the effects of gravity on domes. The gravitational effects upon the pole when in both horizontal and vertical positions are present in a dome — as are all the intermediate conditions between these limits.

It is evident that the vulnerability of horizontal structural components to gravitational forces requires the strongest answering stratagems. Columns are easy; beams are difficult. Rarely are horizontal beams or roofs of history's ruins found intact. In contrast, ancient walls and columns still stand — as do domes.

It is surprising news to the layman that the greatest compressive forces in wedge block domes occur within the top 20 degrees of arc. Pressures there are far greater than those around the bottom caused by the dome's dead weight. Domical pile-ups of wedge-shaped blocks, without tensional bands, tend to yield to gravity in their top parts and oppose it in their bottoms. In failure the unbound haunch height tiers spew outward — thus uncrowding the top tiers which then have ample room to fall inward.

If the dome of wedge blocks is curved inward less rapidly than as in a spherical dome — an up-ended half cigar — this elongated shape practically eliminates the

critical haunch stress area. I have visited the earliest known stone-wedge navigator-priest designed domical structure of man, the tomb of Atreus, in Greece. The Mycenaen Greeks are of the Cretian sea-master pre-Ionian people. This tomb dome of Atreus is of elegantly modulated cigar shape. The Greek name for the shape is *tholus*. The Mycenaen tholus dome is not only the oldest stone dome, but it is the most perfect in its preservation and dimensional elegance of any dome I have seen anywhere.



The Roman arch, developed a thousand years later was a far less sophisticated borrowing of a simple curved section taken from the Greek dome. The Romans employed these domical plane sections in parallel series, holding down the outwardly slippable wedges by superimposed masonry and earth. Because parallel planes do not support one another nor cohere, the whole parallel set was held together, like vertically standing books, by bookends in the form of buttresses erected against the terminal arch faces.

When men developed the capability to produce iron chain in sufficient quantities, closed circles of chain were employed to gird the dome bases and haunches as devices against outward thrusting. However, the vertical wedge-contoured sections of the domes tended to thrust these chains upward so their function was frustrated. Many of these chain bottomed stone domes fell in. Those wedge domes that have survived through time, have been characterized by one form or another of haunch height buttressing.

the Egyptians demonstrated that they could tunnel and hollow out both man-made pyramidal mountains and natural mountains. They riddled the Theban ranges with their tomb chambers, but their awkward, heavy mountain chambering contrasts sharply with the light, graceful ship designs of the world's sailor men.

Vessels represent man's discovery not only of the principles governing separation of liquids and gases, but also of a generalized solution to the problem of local environment control. Vessels embrace the fundamental principle of finite local system mathematics. Vessels, as systems, divide the universe into the within and the without. Within, concavity tends to regenerative reconcentration of the withiness as a result of angular convergence of echoes from its surface. The convex outer surface separates, diffuses, and thins that which impinges upon and echoes from it, this angular divergence thereby emphasizing the withoutness. Hence, convex-concave surfaces are the prime energy pattern differentializers.

Vessles constitute omni-directional spherical dams. They are local environment controlling structures, but they can be challenged by four categories of force patterns:

¶Internal energy pile-up differential beyond the critical limit of the dome dam structure's containment capability.

¶External energy pile-up differential beyond the critical limit of the dome dam structure's exclusion capability.

¶Either internal or external differentials articulated as exquisitely concentrated energy actions.

¶Either internal or external differentials articulated as evenly distributed energy actions.

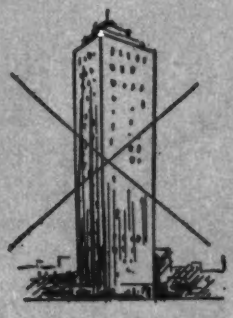
The problem today is to develop a structural system:

¶Capable of sustained enclosure and controlled isolation of conditions favorable to man's activities, ranging in magnitude from single family dwellings to major industries housed on the moon.

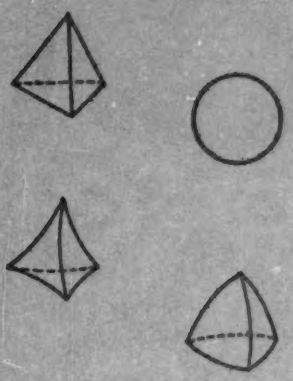
¶Capable of inhibiting all probable stresses and providing all positional advantage requirements.

¶Capable of supporting appropriate mechanisms for valving all impinging random or periodic energies into patterns complementary to man and machines.

¶Capable of penetrations from any direction as desired.



all polyhedra can be subdivided into component tetrahedra, but tetrahedra cannot be subdivided. The tetrahedron (four faceted structure) is the minimum prime divider. It separates the universe into two fundamental domains, the withiness and the withoutness, the included and the excluded, the microcosm and macrocosm. The tetrahedron is a basic system; all structure is a complex of tetrahedrons — or a phase of tetrahedronal transformations.



The regular six-chord-edged tetrahedron comprehends the minimum volume with the most surface. The sphere the most volume with least surface.

When stressed with high relative internal pressure, all polyhedra tend to transform toward the maximum volume with the minimum surface — towards the spherical convex-arc edge tetrahedra.

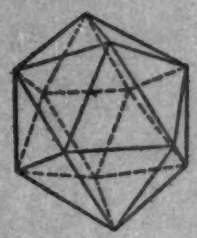
When stressed by high relative external pressure, structures tend to transform toward the chordal or concave tetrahedron.

The planar bound tetrahedra is the zerophase between the convex tetrahedron and the concave tetrahedron.

Great circle arcs represent the shortest surface lines between points on the surface of a sphere, and great circle arc chords represent the shortest distance between two surface points. Therefore the great circle arcs represent the limiting structural tendency of outward surface tensing by internal pressures.

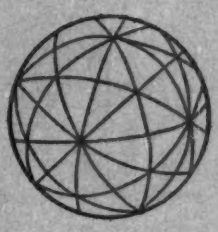
Great circle segment chords represent the optimum position for compression resisting members that oppose surface spreading from external pressure.

we are seeking a structure impervious not only to the differential between internal and external pressures, but also to highly concentrated internal or external loads or impact forces. Yet the structure must permit omnidirectional penetrability.



Chordal edged tetrahedronal structures best resist external pressures, and their vertexes best resist concentrated external pressure and impact forces. Arc edged tetrahedrons best resist internal pressures and their vertexes best resist concentrated internal pressures and impact forces. Both configurations permit omnidirectional valved penetrations. However, as the number of trussed faces of symmetric polyhedra are increased from the chordal and arc structural tetrahedra, through the heirarchy of great circle arc and chord trussed polyhedrons — the octahedron (8) and the icosahedron (20) — the number of vertexes and edges increase, providing more structural interactions for resisting concentrated loads from more directions. Also, more and shorter chords provide increasingly favorable slenderness ratios for the component compression columns.

The icosahedron has the highest number of identical and symmetrical surface truss facets of all great circle defined polyhedra, providing 20 faces, 12 vertexes, and 30 edges. It is evident that if a further approach to the congruence of a chordal polyhedron with a sphere is to be accomplished, the vertexes and trussed facets (or penetration points) must multiply, providing increased advantage in more directions against concentrated loads and more directions permitting penetration. In addition, an ever greater number of ever shorter compression columns will share the load (with more economical slenderness ratios and sections) and a condition will be approached when both the chord length and face angles of the polyhedron will become practically indistinguishable from the arc length and spherical angles of the sphere.



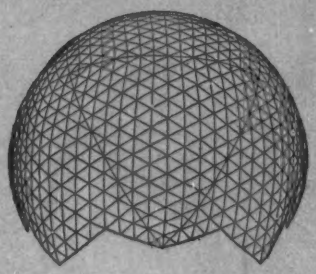
A three-way great circle grid can symmetrically subdivide the triangular facets of the icosahedron. This is what is designated as a three-way grid geodesic structure. Its frequency of modular subdivision of the edge of the icosahedron's facets may be multiplied at will, once the spherical trigonometry rates of change of central and surface angle subdivisions have been solved.

This is the essence of the geodesic structure. At an edge frequency of 16 modules, the arc and chord tend toward indistinguishable differences of dimen-

sion. However, as the number of truss facets increase, the convex vertexial interactions approach a zero altitude condition, which, though ideal for tension or internal pressure, tends to allow concentrated external loads to push the convex chordal vertexes inside out (to a dimpled or concave condition).

if we make a microscopic inspection of a pneumatic balloon, we will find that the balloon skin is a system of holes. The balloon skin is really a subdivisible spherical netting rather than a flexible solid film, this netting restraining the molecules of air much as fish within a seiner's net. Molecules too large to pass through the spherical netting's holes impinge randomly upon the interior webbing of the spherically tensioned net.

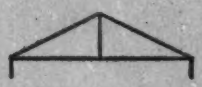
Geodesic spherical nets are such that the islands of interior compressional chordal struts impinge in discreet order at the exact vertices of the enclosing finite tensional network. My independent satellite or moon structures are, then, the most economical, frequency modulated, dynamic balances between outward bound and inward bound resultants of force.



A finite system in tension has no limit of length to section — no inherent slenderness ratio — as do the explicitly limited slenderness ratios of compression members. Therefore, in the Geodesic Tensegrity (my name for the discontinuous-compression, continuous-tension structure) we are able to assemble unprecedentedly large, clear span structures whose over-all diameter dimensions are limited only by the tensile strength of the material. We can go, therefore, into the same magnitudes of clear-span dimensions as our largest suspension bridges.

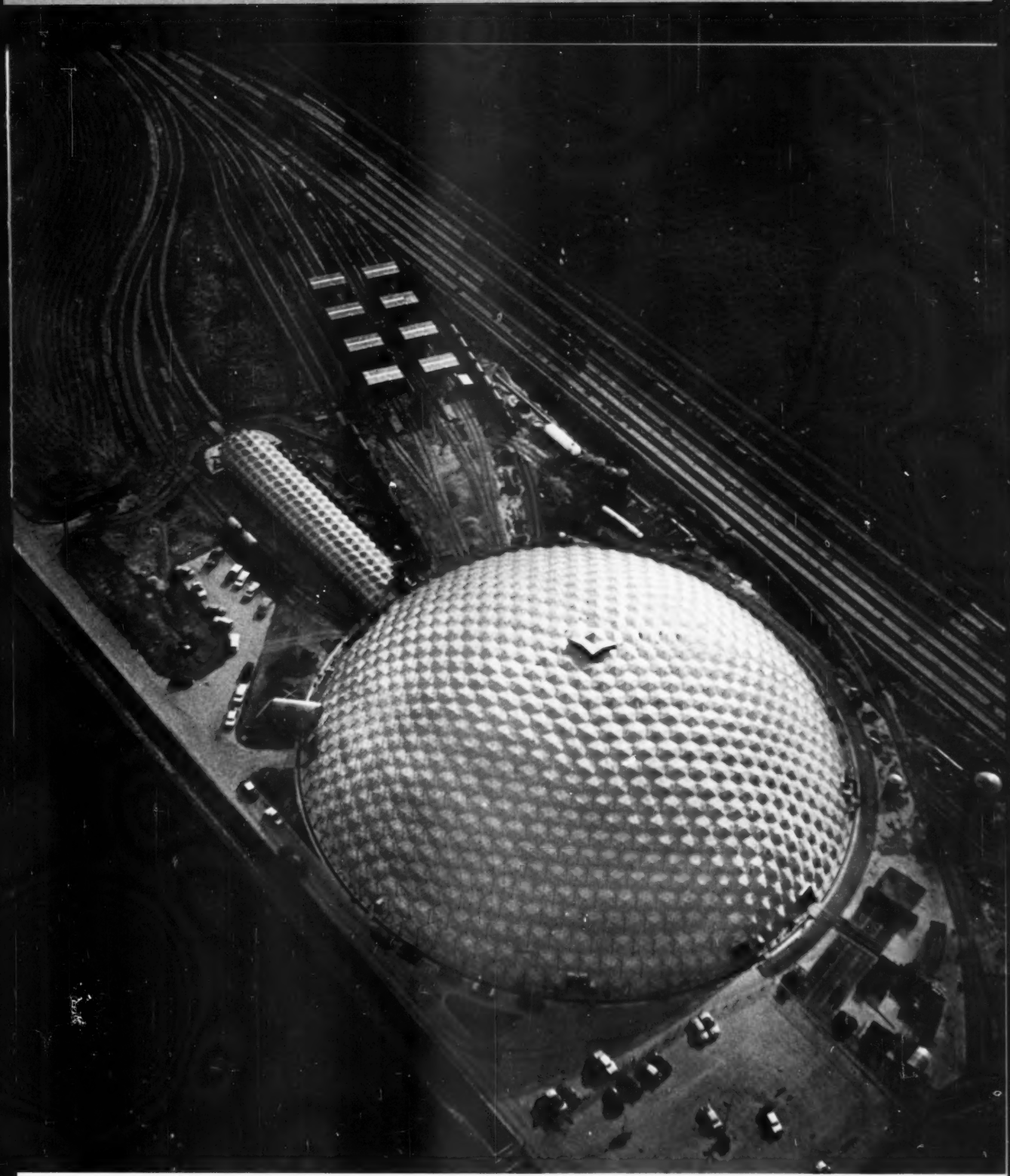
suspension bridge vertical cables are parallel to one another, and therefore give no anti-rhombic structural stability, but the geodesic tensegrity tension members cross one another in great-circle-chord triangulations, thus providing dimensional stability.

These technical concepts alter all old engineering ideas regarding the relative increase of weight with size of structure. In Egyptian pyramid buildings, doubling of the linear base dimensions brought about a four-fold increase in the over-all surface and an eight-fold increase in the over-all weight. Men later learned that the highest capability in strength of structures existed in their surfaces. So they hollowed out their buildings. Then they found that the structural strength at the surface was not provided by the solid quality of the shell but by triangularly interstabilized lines of force operating within the shell. So they perforated the shell with holes between the force lines. The minimum holes were triangular. The pattern of triangulated force lines peppered with triangular holes in the hollowed out structural shell became what we call a truss.

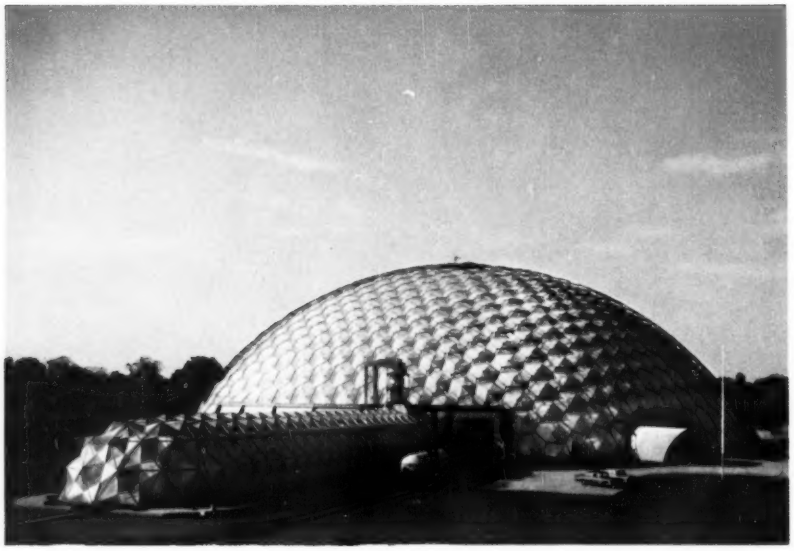


We can say then that the hollowing out automatically reduced the third power volumetric multiplication of relative weight increase of structures as they increase in respect to their primary linear dimensions. We can also say that the piercing of the shells with triangular holes reduced the solid or continuous surface of second power increase of the shells, and brought the rate of structures' weight growth into something nearer an over-all first power or linear rate of gain. When we introduce the tensegrity structure with its many surprises, we can see that we have broken through to a structural technique which permits a progressively decreasing weight to size ratio as size increases.

As geodesic tensegrity frequencies increase, the sizes of the islands of compression diminish. Islands of compression are the only residual "solids," and their diminishing size diminishes their weights in a cube root progression. Thus we can state that the higher the frequency, the more ephemeral the tensegrity complex, the less the total weight of structure per given level of performance, and the less vulnerable the whole structure to violations by any or many inwardly or outwardly originating forces.



Union Tank Car Company's giant Union Domes at Baton Rouge, La. (pictured above) and Wood River, Ill. are the world's largest circular buildings without internal or external supports. As high as a 10-story office building and big enough inside (110,000 square feet) to hold a football or baseball field, they are 120 feet in height and 380 feet in diameter. The Domes are the first major industrial application of the geodesic principle of design and are made of hexagonal steel panels welded together. The Wood River Dome was designed, fabricated and erected for Union Tank Car Company by its Graver Tank & Mfg. Co. division, which constructs domes for commercial use.



The Baton Rouge (right) and Wood River Domes were designed to house regional tank car repair and maintenance facilities for Union Tank Car Company. Tank cars are repaired in the main dome area and painted in the 200-foot long connecting tunnel (foreground).

Tank car repair operations inside the Baton Rouge Dome center around a second dome-shaped structure 80 feet (seven stories) high and 100 feet in diameter. The circular arrangement provides maximum flexibility in movement of cars and materials. A transfer table (foreground) moves cars to desired repair positions. The Wood River Dome will have a similar repair area layout.

Dome Structures . . .

A Reconstruction . . . . Contrast in Technologies

Saint Hedwig's Cathedral in East Berlin as it stood before World War II. Sketch illustrates original timber construction which was later reinforced by wrought iron tension bands at the base.

Herbert David, who designed the reconstructed St. Hedwig's dome, is a consulting engineer and the vice president and manager of the German consulting engineers' association, Verein Beratender Ingenieure of Berlin. His report to CONSULTING ENGINEER *on this interesting project was translated by a fellow Berliner, Johannes Rosenthal, who is also a consulting engineer and the president of VBI of Berlin. David was educated in the technical schools of Germany, and after many years of experience with both consulting and contracting firms, he established his own consulting firm in 1938. He became a member of VBI in 1941. Project architect was Dipl. Ing. Felix Hinssen.*

Precast concrete dome section is lifted into place by hand winch and supported by temporary centering.

THE CORNERSTONE of Saint Hedwig's Cathedral was laid on July 13, 1747. The most interesting (if probably apocryphal) story of its origin is told by the tour guides on the sightseeing buses that shuttle behind the Iron Curtain to the site of Saint Hedwigs, in East Berlin.

Frederic II, protestant King of Prussia, was engaged in discussions with the local Roman Catholic bishop about the propriety of his erecting a cathedral on the royally created street, Unter den Linden. The discussions grew rather heated, when, goaded to the limit of royal serenity, "Old Fritz" struck the table with his fist, accidentally turning his teacup upside down. Shamed by this outburst, the Monarch turned tractable and granted permission for the building of a cathedral, "provided it is shaped like this!" (the overturned teacup). In fact, the idea so intrigued him that he made many sketches of the structure, some of which are still in existence.

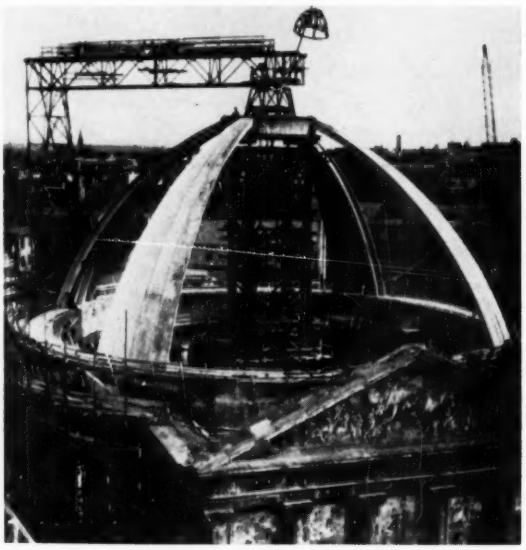
The building of Saint Hedwigs was beset by many problems, but finally it was consecrated in 1773. Its first dome, set on a cylindrical masonry wall, was a wooden structure, with the thrust at the base taken up by a ring of wooden beams. Later, the tension ring was reinforced by bands of wrought iron. Outside diameter of the dome was 131 feet and the elevation from street level to the tip of the golden cross surmounting it was 177 feet. It stood until bombed out in 1943.

Reconstruction plans were begun in 1946, when Herbert David designed a reinforced concrete shell with a thickness of 4¾ inches at the base and 2⅜ inches at the top. Unfortunately, there was no contractor in the East Berlin area at that time with the equipment required for the erection job. So, to make construction easier and reduce form costs, David came up with a new design in precast concrete. This called for 84 segments resting on the tension ring above the wall and ending at a 19½-ft inside diameter compression ring at the top. The segments, or beams, were cast in the form of a T, with a width of 53½ inches at the base and 14⅛ inches at the top. The plate section of the beams is only 2-in. thick.

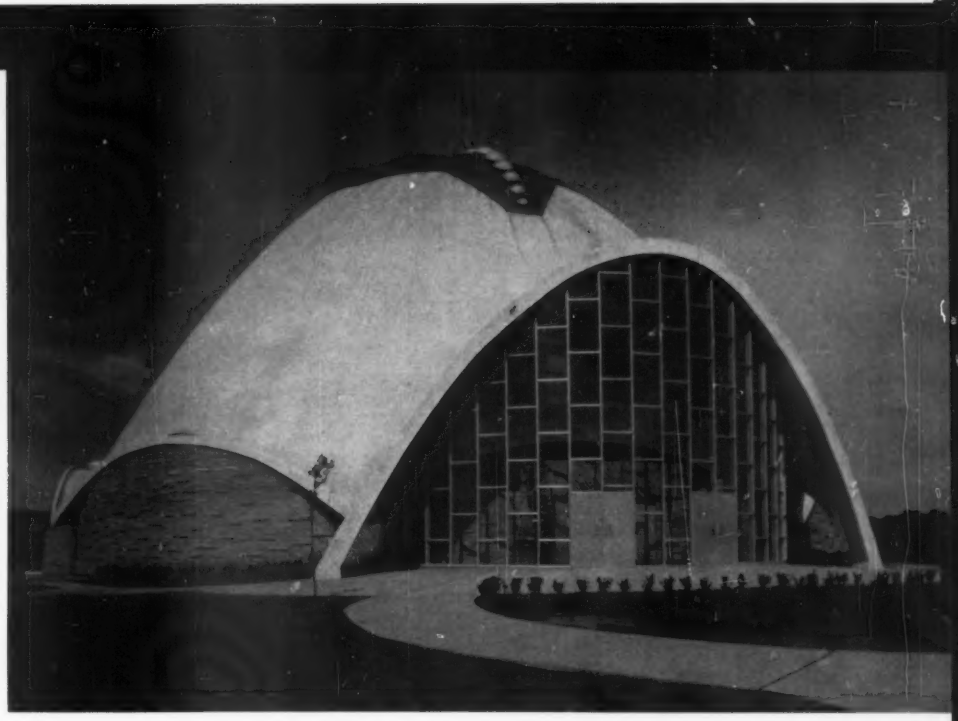
Forms for the dome segments were built on the site from brick and concrete. To insure a smooth facing on the finished units, the forms were ground, polished, and treated with a surface coating to prevent adherence of the freshly poured concrete. After proper curing, the cast segments were turned out by compressed air injected through pipes imbedded in the forms.

Erection was accomplished by the use of hand winches which lifted the segments into position around a temporary centering. After all the segments were in place, the precast units were connected to the tension and compression rings with reinforcing rods, concrete was poured in, and the centering removed after curing. Movement between the tension ring and supporting walls was permitted by the insertion of two plates which were surface ground and copper plated. The upper plate is connected to the tension ring, and the lower plate is anchored on top of the outside walls. Tangential doweling connects them.

It is interesting to note that the dead load of the new concrete dome is less than that of the old wooden one. In all, the reconstruction required 114,000 cubic feet of concrete, 66 tons of reinforcing steel, 22 tons of steel plates, 30 tons of steel girders, and 1360 cubic feet of lumber.



Total of 84 T-section members make up new dome which has a dead weight less than the old wooden structure.



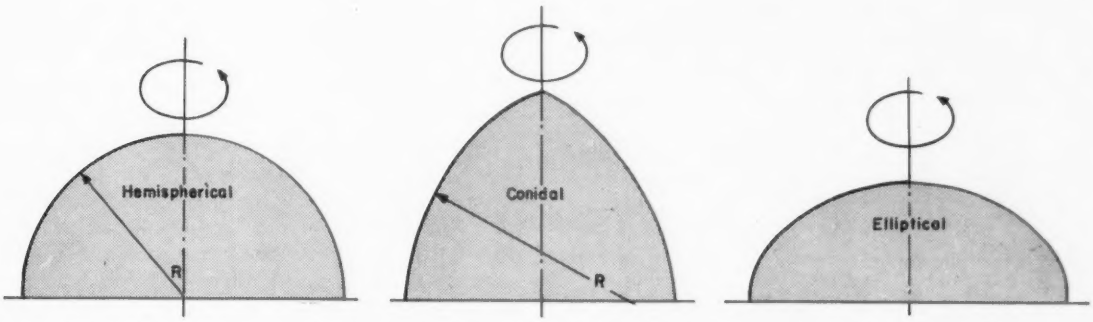
Thin shell concrete church in Oklahoma City designed by Conner & Pojezny, project architect, and Warren E. Sullivan, structural consultant.

Dome Structures . . .
Engineering Aspects

THE POPULARITY OF THE DOME as a structural form for other than churches or monumental buildings has been a rather startling phenomena. Domes are now being used by large and small industry, by retail stores, offices, restaurants, and schools, and are being seriously considered as proper structural forms for hospitals. Meanwhile, the U.S. Marine Corps is rapidly replacing its traditional field shelters with domes of portable or throw-away design.

The masonry dome of antiquity is no longer practical because of its inherently high labor and scaffolding costs. However, there are many design forms in use today that take full advantage of the improved structural qualities of modern materials. Some of the more popular are:

Thin Shelled Concrete – Not too long ago, thin shelled concrete dome structure design was the limited domain of a few designers working under patent licensing arrangements. Then the ASCE published a manual of shell design which was later followed by one from the Portland Cement Association. There is a growing body of literature covering



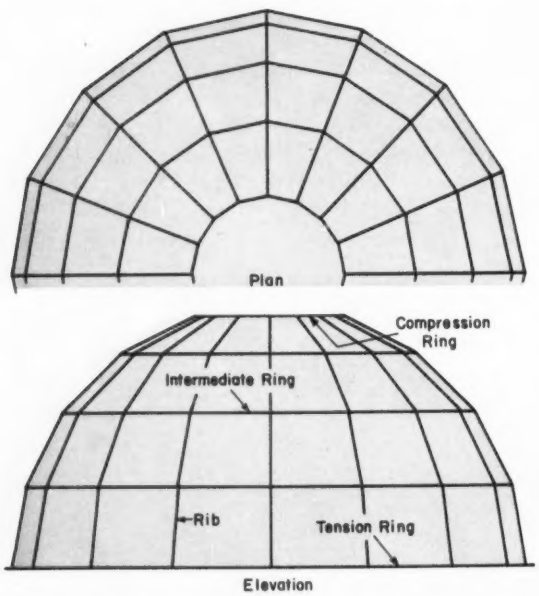
Most thin shell concrete domes are surfaces of revolution based on the arc of a circle or an ellipse.

the subject, and thin shelled concrete designs are now well within the capabilities of any competent structural engineer.

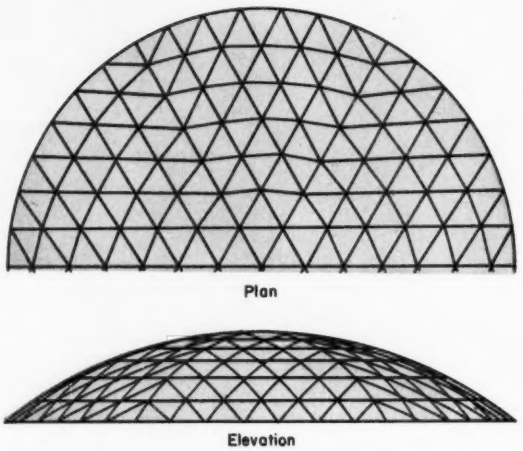
The high labor cost of form work and of setting reinforcing steel has been a limiting factor in the wider use of thin shelled concrete in high labor cost areas such as the United States. Thus, until recently, it was the engineers of Spain, Italy, and Mexico who came up with daring designs far in advance of those used in the U.S.

However, many ingenious methods have been developed to compensate for high labor cost. For example, sprayed concrete has been used to some extent, and thin shelled domes have been constructed on forms of natural or man-made mounds of earth. Once the concrete has set, it is a simple matter to remove the earth below the shell. Other techniques depend on movable, reusable scaffolding, with only a small portion of the shell covered in each of a series of separate pours.

Ribbed Domes – Typical of the ribbed design is the precast dome for the Cathedral of Saint Hedwig in East Berlin. (see page 97) Similar in concept are many designs in metal and wood. The metal ribbed dome can be based on a series of formed ribs which actually follow the true arc of a circle. They may also be simple chord sections of standard structural shapes, with the length of the member determining the degree to which the dome approaches a true sphere. The solid web rib can also be replaced with an open truss.



Ribbed domes can be designed with chordal members or they can be curved to the true spherical arc.



Lamella domes use an essentially parallel system of ribs which results in a diamond or triangular pattern.

When fabricated of wooden structural elements, the ribbed dome usually employs laminated members, but not always – trussed systems have been constructed with sawn lumber.

The ribbed dome of concrete, either cast-in-place or precast, may result in an interior surface with an extremely pleasing pattern, thus requiring no interior finish. The work of Nervi, in Italy, provides many examples of excellent combining of good structural design and aesthetics. This is also true of many designs in steel.

Lamella Domes – In lamella design the ribs of the system run approximately parallel instead of from a point on the bottom to the top center. This results in a diamond grid which can be subdivided into triangles. Structural members may be either straight line or curved. Designs of this type have been fabricated in metal, sawn lumber, or laminated wood. Connections can be rigid, as are many welded steel systems. The lamella design is structurally indeterminate, and requires a combination of engineering approximations and tests.

Geodesic Domes – Geodesic structures are covered by patents issued to R. Buckminster Fuller and can probably be described best by direct quotation from the original patent (2,682,235) granted in 1954: " . . . [the] building framework is one of generally spherical form in which the longitudinal centerlines of the main structural elements lie substantially in great circle planes whose intersections with a common sphere form grids comprising substantially equilateral spherical triangles. The visible pattern formed by the structural elements themselves does not necessarily show grids of equilateral triangles, for the visible grids may be equilateral hexagons, the diamonds being made up of two

equilateral triangles and the hexagons being made up of six equilateral triangles. The individual triangles, diamonds or hexagons as the case may be, may be made of straight or flat elements, in which circumstance they define flat or plane figures; or they may be made of arcuate or spherical form to define spherical figures. Either way, the complete structure will be spherical, or substantially so. And either way, the individual structural elements are so arranged as to be aligned with great circles of a common sphere.

"... the grids are formed on the faces of a spherical icosahedron. Each of the twenty equal spherical equilateral triangles which form the "faces" of this construction is modularly divided along its edges. Lines connecting these modularly divided edges in a three-way great circle grid provide the outline for the plan of construction. I have found that if the structural members be aligned with the lines of the grids, the resulting framework will be characterized by more uniform stressing of the individual members than is possible with any construction heretofore known. The structural members may be aligned with all lines of the three-way grid, or just with selected ones of those lines. If the members are arcuate, or spherical, they will coincide with the grid lines; if they are straight, or flat, they will be chords of the great circles which are the grid lines."

Actually, the geodesic structure has evolved into a number of different types, all conforming to the general definition.

¶ Frame type – A geodesic frame is formed of individual members, all lying in approximately the same enveloping sphere. A surface may be applied to, or suspended from, this frame.

¶ Truss type – A truss is formed from individual members which have a definite depth, with top and bottom members lying approximately in two distinct enveloping spheres. Again, a surface may be applied to, or suspended from, the truss.

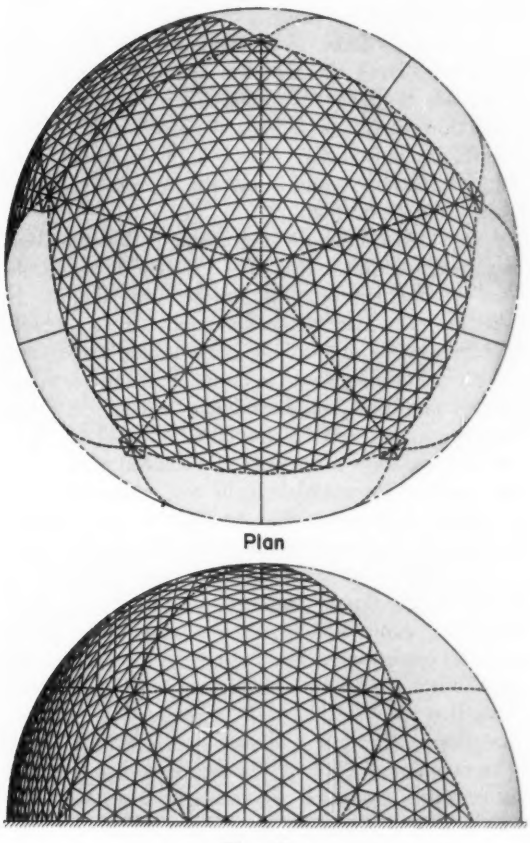
¶ Stressed Skin – The geodesic frame and the skin are combined to form what is essentially a truss, by welding or riveting them together. Thus, the surface actually becomes a stress carrying member.

¶ Molded Pan – In the molded pan design the surface is formed with edge members that are connected to give a structural framing system.

¶ Formed Surface – Flat sheets are deformed and connected together so as to form an essentially spherical surface with a stress distribution typical of the geodesic frame.

Several varieties of dome structures have evolved from the Fuller concept, with the prefabricated structures of the Kaiser Aluminum Company the most widely known. The company presently has six standard models, all licensed under the Fuller patents. Also widely known are the two huge steel domes used as railroad car repair centers by the Union Tank Car Company. Many other firms are licensed under the Fuller patents, and they are making domes of metal, plywood, plastic, and paper.

This classification of dome structures is complicated by the fact that many designs refuse to fit any general type. For example, there are many non-Fuller dome structures that incorporate elements of the geodesic principle but are clearly neither patent infringing nor patentable. At the same time, concrete structures are further subject to classification as precast or poured in place and pretensioned prestressed, postensioned prestressed. Thus, an attempt at refined classification of dome structures is frustrated by the fact that many of them are, in one or a number of ways, unique.

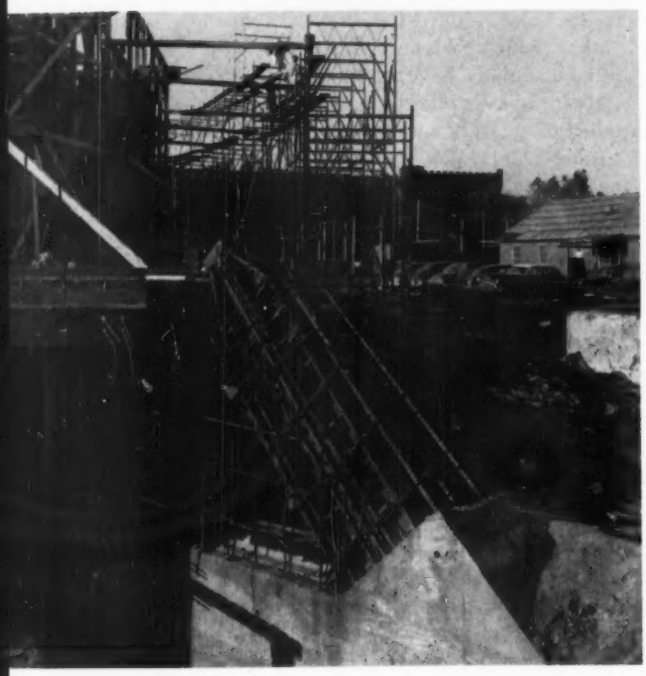


Geodesic domes use a grid system based on the twenty faces of a spherical icosahedron cut by great circles.

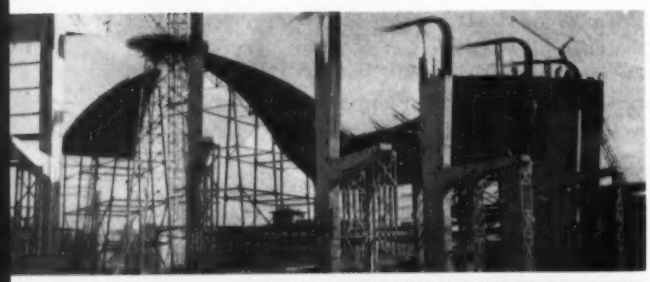
Structural Engineering Aspects

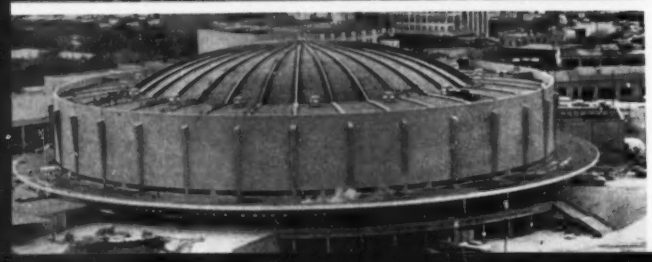
The structural basis of the dome is generally the hemisphere. Since it is able to enclose more volume

Triangular dome for MIT Auditorium has only three support points, requiring careful stress transfer design.



Only 45-sq in. of bearing area take one third of MIT dome load into heavily reinforced concrete buttress.





Dallas Convention Center has reinforced concrete dome cast in bow tie pattern on reusable rotating forms.

per unit of surface than any other shape, it can lend an air of importance to monumental structures. However, designers have long been aware that something less than a full hemisphere will cover more area with less surface. For example, a spherical surface with a height of 1/3 the diameter will require only 67 percent of the surface area of the hemisphere to cover 89 percent of the hemisphere's floor area. For a height of 1/4 the diameter, the surface area is only 50 percent while the covered floor area is 75.

However, as the dome becomes a smaller segment of the hemisphere, two things happen. The amount of headroom decreases, and the magnitude of the horizontal forces at the ground increases, as do the actual stresses in the upper section of the dome. Thus, if too flat an arc is chosen, the dome surface must be mounted on supports to improve headroom, and the supporting walls or columns must be designed to take the increased horizontal thrust, or this thrust eliminated or reduced by the use of tension rings. Many extremely thin shelled concrete domes, forming only a small part of a total spherical surface, have been built with heavy tension rings.

Since most dome structures have as their goal the achievement of long clear spans, the attendant problems of deflection must be recognized. This deflection varies as a higher power of the span length, the applicable power being a function of the proportions established for a specific structural design situation.

Large deflections are important to the structural engineer, for quite often they create difficult problems in connection with architectural details. In addition, they may create secondary stresses which, though usually ignored in conventional structures, are of such a magnitude in domes that they demand careful analysis. Thus, secondary affects in dome design require refined methods of analysis. Obviously, on three dimensionally curved structures, the analysis immediately calls for mathematics of a higher order than that typical of conventional buildings or even structures curved in two planes.

"One integrated whole" is an expression that best describes the dome structure. In itself this sounds desirable, especially to some of the more philosophical engineers and architects. However, the concept is not without its negative values. For it follows that when a dome is conceived as a pure, integrated whole, it will not stand in part. Until it is completed (and it is hard to complete) it is an unstable structure. Accordingly, a considerable

portion of the design time must be devoted to the development of practical and economical methods of construction.

Commenting on specific problems encountered in dome design, Donald R. Peirce, of Amman & Whitney, drew on the firm's important projects, past and present. On the MIT Auditorium, Saarinen was seeking the illusion of knife edge supports for the huge spherical triangle dome. The final design called for 20,000 square feet of shell to be supported on less than one square foot of bearing area, with three surfaces measuring only 4½ by 10 inches at their smallest section. This detail was the result of an obviously difficult study in stress transfer. The shell reactions had to be carried from concrete and reinforcing steel into the bearing in a very short distance – then back into concrete and reinforcing steel in the buttresses.

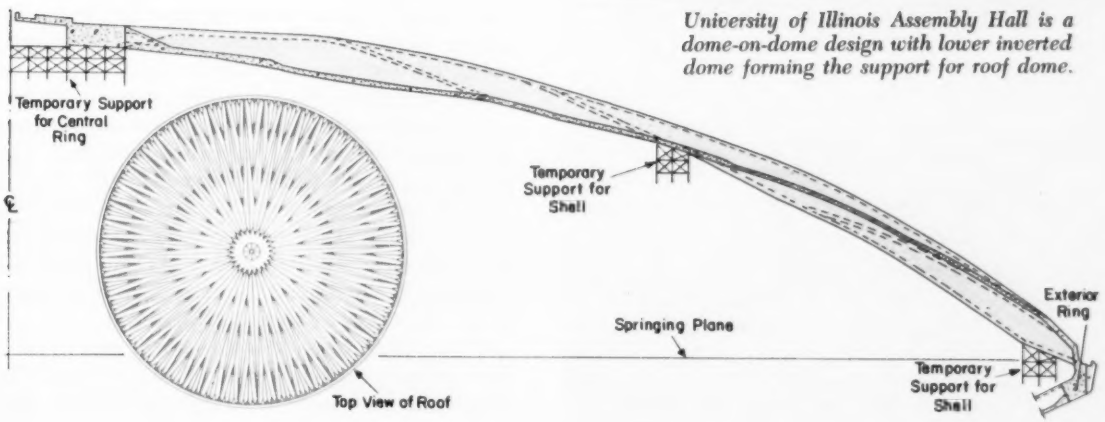
When Amman & Whitney undertook the design of the Dallas Convention Center, a careful cost analysis resulted in the decision to construct the dome in segments. A bow tie plan was used, with opposite segments being poured at the same time. This required the erection of a temporary tower at the center and a rather complicated rotating falsework and form structure. However, with 16 reuses this permitted considerable saving over conventional methods. Splitting the dome in pieces obviously eliminates ring stresses and penalizes the shell. Thus, the designer must counter the cost of increased materials in a necessarily thicker shell with savings in construction costs.

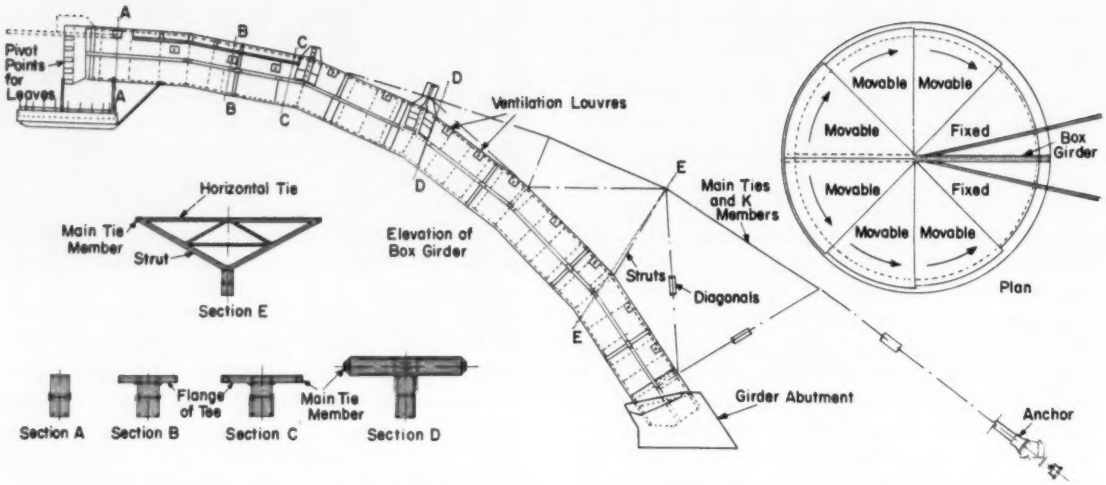
The University of Illinois Assembly Hall, now under construction, will use the same construction method used in Dallas. The longer span of 400 feet will require more temporary supports, and horizontal reactions are to be carried in a post tensioned ring girder. Thus, until the dome is complete, ring girder tensioning by the Preload Company, Inc., cannot be completed.

As far as Amman & Whitney are concerned, the highlight of the University of Illinois project was the close cooperation between engineer and architect. Harrison & Abramovitz developed an architectural concept that required an inverted or bowl shaped dome to support the roof dome. Ring girders, therefore, had to supply the horizontal reaction not only for the roof dome but also for the seating bowl. Now, an engineer is instinctively concerned with getting the load down to the ground as quickly and simply as possible, but, in this instance, this was not what the architect desired. So the final concept was developed as the end product of many collaborative trial shapes and systems. It should be noted that the mechanical engineering firm, Syska & Hennessy, was also closely involved in the early design stages. Thus, whatever the professional critics of architecture and engineering may have to say about the completed structure, it is the product of a high order of architect-engineer collaboration.

The Pittsburgh Auditorium (again by Amman & Whitney) involves the problem of rotating dome segments, but the major problem centered around the design of the cantilever frame supporting these segments. Since the frame cantilevers 200 feet, it is subject to very large lateral as well as vertical loads. Because the roof segments may be in any

University of Illinois Assembly Hall is a dome-on-dome design with lower inverted dome forming the support for roof dome.





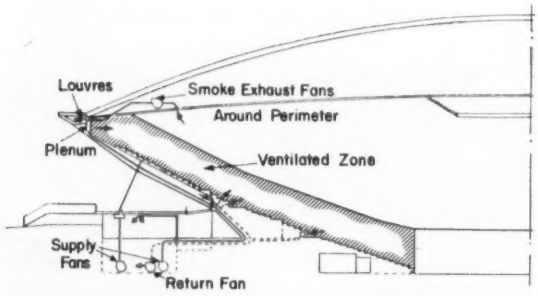
Pittsburgh Auditorium has huge cantilever frame supporting movable dome segments in variable positions.

of an almost infinite combination of positions and the wind may blow in any direction, design was necessarily based on limiting conditions.

Mechanical and Electrical Engineering

Since most mechanical and electrical equipment is designed for conventional buildings with corners and flat surfaces, it is not surprising that dome structures with their curves sometimes present problems of layout. Since one of the advantages of the dome is its ability to use relatively light structural members or thin shelled concrete, there is nowhere to hide pipes and ductwork.

It is possible to beef up the structure so that it can support hanging or attached loads, but in all but industrial buildings, this is aesthetically unpleasant. For that reason, mechanical and electrical services are generally relegated to the perimeter where they can be hidden in walls or columns. Larger equipment items are frequently located either in a special structure adjacent to the dome, in basement areas, or in specially enclosed areas under the dome.



University of Illinois Assembly Hall has mechanical equipment well isolated from main areas of activity.

According to one well known acoustical consultant, dome enthusiasts, both engineers and architects, frequently forget or ignore a well known fact. The dome is an acoustical monstrosity!

Actually, this is not as bad as it sounds. The dome is an economically sound structure where large clear span areas are desired, it presents a pleasing appearance from the outside, and it can be acoustically corrected on the inside when necessary. Surprisingly enough, this has been done frequently with false ceilings, above and upon which can be located a variety of mechanical and electrical services. However, this is only good when it has been properly planned at an early stage of the design. As an afterthought, it can be expensive and extremely inefficient.

Because of its erratic acoustical characteristics, the dome structure should be well insulated from any noise making mechanical equipment. The location and enclosure of this equipment may benefit a great deal from the early advice of a qualified acoustical engineer.

The acoustical design criteria for speech and music can be studied under four headings. They are background noise, loudness, distribution, and reverberation. Robert B. Newman, of the firm of Bolt, Beranek and Newman, Inc., acoustical engineers, has discussed at a number of technical meetings the acoustics of thin shelled structures with particular reference to these four areas. Some of his comments are especially pertinent.

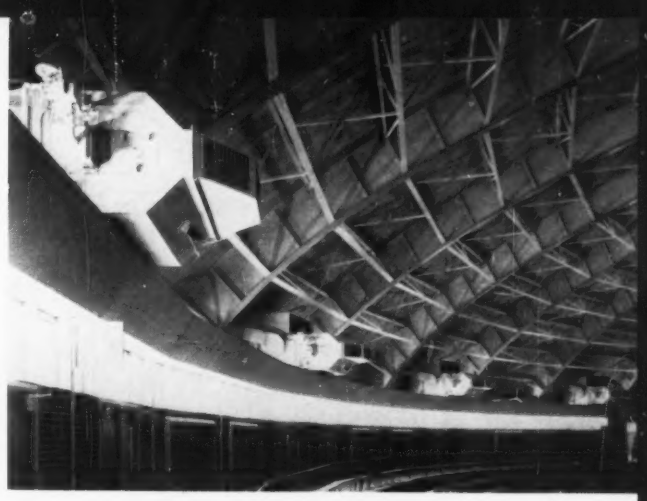
Background Noises – It is enough to say that a 3 or 4 inch concrete shell without an attic is seldom adequate to keep out the normal noises of city traf-

fic, overhead aircraft, or similar activities, where use as an auditorium is the prime objective. If it is a shop or a factory building, that is a different story, but certainly for auditorium use a single thin shell is usually not adequate protection if there is normal ambient noise.

Loudness and Distribution – Enclosing surfaces should be used properly if the requirements of adequate loudness and good distribution of sound are to be satisfied. Otherwise an audience may receive sound directly from the source, which is comparable to an "open field" condition. For example, bad design in a room results from putting absorbing material all over the ceiling which is just like moving the audience out into a corn field– the enclosure offers no advantage. In auditorium rooms it is important to have hard sound-reflecting surfaces for ceilings and walls to give useful reinforcement of sound energy down and into the audience. Tilting the ceiling up from the proscenium will send the reflections way back into the audience and add to the apparent loudness of sound from the source. In addition, if the rear ceiling surfaces are brought down towards the top of the doors at the back of the seating space, useful reinforcement into the ears of the listeners is again achieved. In addition to simple directivity characteristics at the surfaces, it is important to get some diffusion characteristics – some roughness, some irregularities – to give a listener a number of discrete reflections from a number of points on the ceiling.

The problem in the auditorium with a domed or barrel-vaulted roof is more one of focusing the first reflections into the audience area. Certain portions of the audience will receive unusual concentrations of sound from certain portions of the stage. One would find, for example, that in certain seating areas the second violins would sound quite loud, and in other areas the harp could be heard more readily than any of the other instruments. This type of selective reinforcement is undesirable. In the new MIT auditorium a number of "clouds" have been placed over the stage area and over a large portion of the seating area. These clouds obscure portions of the domed surface that would give troublesome focused reflection and, at the same time, provide a certain amount of acoustic roughness to the surface so the result is a diffuse reflection rather than a sharp one. Thus, a better listening atmosphere is created.

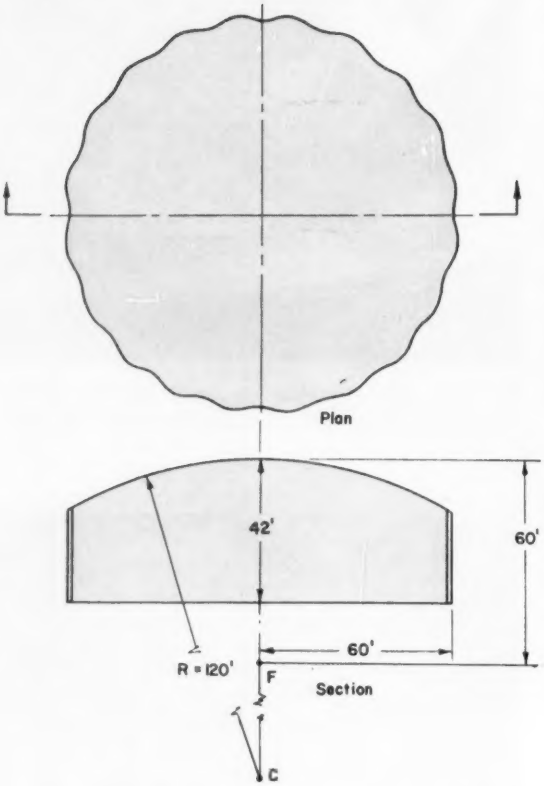
This type of solution may leave something to be desired, but the simple fact is that the geometry



Gas fired unit heaters are supported between the rib members of dome, with exhaust grilles under the seats.

Dome within a dome makes an attractive, noiseproof arrangement for banking operations in Oklahoma City.

Acoustical spray and suspended acoustical clouds are used to improve auditorium sound conditions.



These dimensions plus hard, sound reflective floor give domed room extremely bad acoustical properties.

of a dome is not really good for an auditorium, and corrective measures must be taken.

Reverberation – In a situation where there is a flat floor with a dome way up high, the center of curvature is well above the heads of people standing on the floor. The listener will hardly know that the dome is there, from an acoustical standpoint. The focusing of sound will all be up in the air. At the focal point there will be a real image, which re-radiates sound in a diverging wave. Thus, a new radiation from the real source comes back to the listener. It may be an echo, but it probably is a diffuse one which causes little trouble. But when flatter geometries put the listener somewhere between the center of curvature and the curved surface, real difficulties may be encountered.

For example, one large, circular room with acoustically treated walls and domed ceiling became almost useless to its owner because of its peculiar acoustical properties. The dome had a 120-ft radius and the room was 120 feet across. The apex of the dome was 42 feet above the floor, making the focal point of the acoustic mirror about 20 feet below the floor. The dome was treated with acoustic plaster. The ceiling was lighted with about 250,000 watts of incandescent light, and, in order to obtain a high light reflectance, the acoustic plaster on the dome was painted with a number of coats of white paint.

When anyone walked into this room and began talking or making any type of sound, it was immediately noticed that at about 20 feet from the side walls a rapid repetition of every sound could be heard. Actually, the room made 25 distinctly countable repetitions. These occurred at about 1/3 second intervals and lasted for about eight seconds.

This phenomenon proved extremely troublesome and made the room almost worthless for the display of automobiles, since conversation was practically impossible. The multiple reflection of sound back and forth between the curved ceiling surface and the flat floor surface made the spoken word unintelligible. Actually, in this particular geometry, the sound had to make five round trips between floor and ceiling before it was reconcentrated enough to be heard as one of the repetitions. On each reflection from the ceiling and floor a little sound energy was lost, but not nearly enough.

It should be emphasized that domes do not always create acoustical problems. However, this type of structure does introduce many new factors which, under the proper circumstances, can contribute to poor acoustics.

The heating and ventilating of dome structures has certain inherent advantages that become more marked as the surface approaches a true hemisphere. For example, if it were practical to supply heat from a central source at the center of the base of the structure, the dome shape would tend to spread it evenly about the total volume by reflection. This consideration does not, unfortunately, take into account the heat loss from a thin, uninsulated surface and is more applicable to small than large structures.

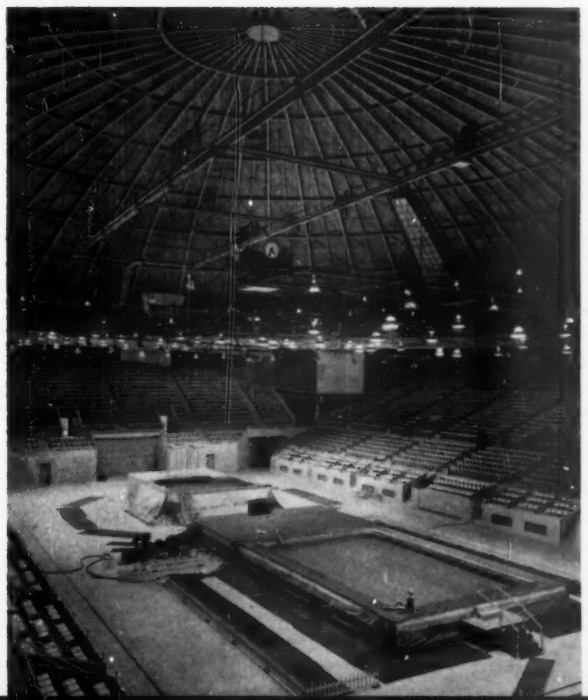
In summer months, with the sun's rays deflected from the surface, there is a minimum of heat gain. In addition, since the heat would concentrate at the top of the dome, the use of an overhead ventilation opening permits a natural draft. This advantage is of doubtful value where domes are used for large gatherings, but there is some indication that for large industrial structures there are significant benefits.

Lighting problems with dome structures usually are solved by means of suspended fixtures. A number of ingenious devices have been used, including adjustable suspension systems which may be raised or lowered to meet specific conditions of building use. Attempts to use the dome ceiling as a reflective surface to light the floor area indirectly have not been particularly successful.

Dome Structures . . .

The Charlotte Coliseum has a ribbed dome of standard wide flange sections resting on concrete columns.

Designs in Metal



SPEED OF ERECTION, minimum scaffolding, reduced weight, and structural adaptability to the strain of concentrated loads are all advantages common to metal dome construction. One of the best known of this type of structures is the Charlotte Coliseum, which for a time was the world's largest dome. It was designed by Severud-Elstad-Krueger-Associates, in association with the architectural firm of A. G. Odell, Jr., and Associates.

The 334-ft diameter, all welded, radial ribbed dome uses only 970 tons of steel (22 pounds per square foot). It is supported on 48 cast-in-place concrete columns which take only the vertical component of the inclined forces acting on the rim of the dome. The considerably larger horizontal components of these forces are taken by an equalizing steel tension ring resting on the columns. To compensate for elongation of the tension ring, the col-

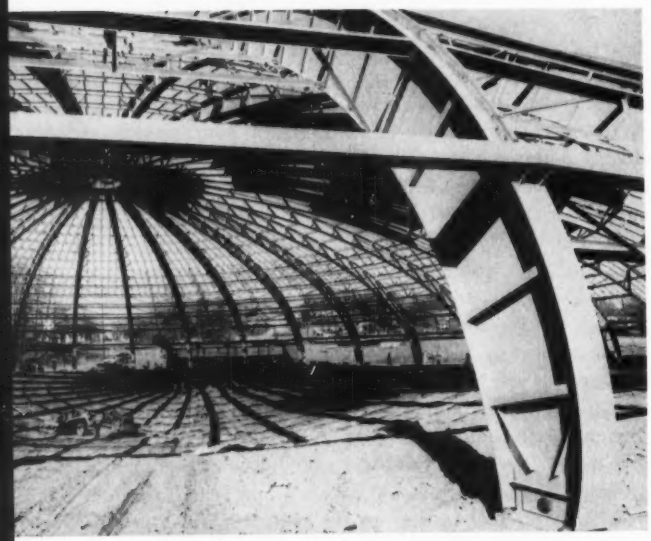
Steel framing for lights is cable suspended so that lighting conditions can be varied as occasion demands.

Fabricated girder is pin connected to plate which is in turn bolted to heavy tunnel slab tension ring.

umns were strained inward and the tension ring bolted to them before the full weight of the dome was applied.

During construction the 46-ft diameter central compression ring was mounted on an erection tower. Rib sections were assembled at ground level and cable tied for erection between the compression and tension ring. Sheet aluminum covers the roof.

While the Charlotte Coliseum dome was designed with standard wide flange sections and rod,



Rib type steel dome uses fabricated girders with standard structural shapes for lateral members.

the Alexander Memorial Center at the Georgia Institute of Technology was designed with 32 elliptical curved fabricated girders joined to a compression ring at the center. The architects, Aeck Associates and the structural engineers, Morris, Boehmig & Tindel, Inc. agreed on pin connections at the base of the arch members, with the base plate at each ground point carrying stresses into the slab beneath with four 2-in. steel bolts. Thrust is actually carried by a reinforced concrete tension ring in the form of a circular tunnel which also acts as an air exhaust chamber.

The circular arena has a 270-ft diameter, with the steel arches overhead trussed at 8-ft intervals and covered with porex boards and a 40-lb tin roof with standing seams. Total weight of the dome is 862 tons, or 24 psf, including structural steel, roof deck, tin roof, and paint.

Site conditions for the Georgia Tech Center were not ideal. A 35-ft high hill stood at one corner, with 35 feet of fill at the center. Under this fill was an underground stream and a 7-ft sewer. Thus the tunnel tension ring had to be supported on steel piles under the arched girder points, except at a few places where it rested on rock.

To get satisfactory interior lighting for basketball, a combination of direct and indirect lighting was used. Reflected ceiling light was reinforced with direct downlighting to give a 59 footcandle minimum lighting level on the playing floor. Gas fired unit heaters circulate air varying in make up from 100 percent fresh to 100 percent tempered and recirculated, with 310,000 cfm for summer time and 230,000 cfm for winter. The perimeter of the playing floor has continuous grilles through which the air blown by the unit heaters is drawn upward under the seating and is exhausted to the outside by fans. Project cost was $1.5 million.

Domed structures need not always be large to be economical. For example, the new Costa Mesa High School in Southern California has an extensive and expensive building program under way. Later there will be a cafeteria, but for the present the architectural firm of Lind, Pleger, Blurock, Hougan and Ellerbrook wanted to provide an eating shelter and snack bar. Working with structural engineer John A. Martin, they chose a 100-ft diameter dome.

Framed in structural steel and suspended from three supporting steel arches, the new dome will accommodate 2000 students and supplement the future cafeteria structure. The dome is 36 feet high at its apex and is covered with a poured gypsum roof, 6-in. thick.

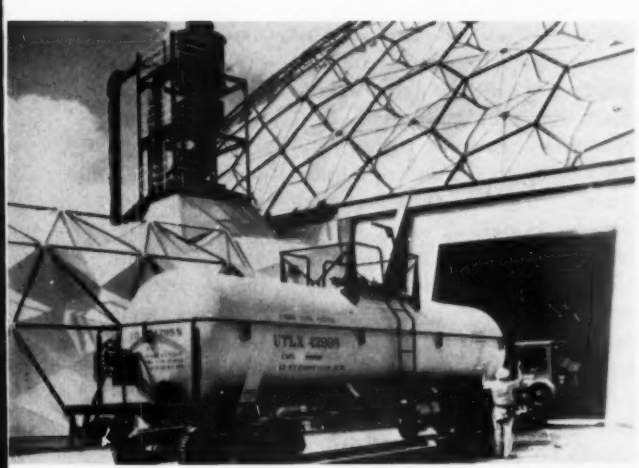
Geodesic Domes in Steel

The industrial application of two steel geodesic domes by the Union Tank Car Company is of

The Alexander Memorial center at Georiga Institute of Technology is an attractive ribbed dome structure.

California high school uses a 100-ft diameter steel dome for an open air lunch and recreation shelter.

engineering significance because the two units, despite their identical appearance, contrast sharply in their basic design and erection. The first, located at Baton Rouge, was fabricated and erected in the field by Union Tank from a design by Synergetics, Inc. The second, at Wood River, was designed, shop fabricated and field erected by the Graver Tank & Mfg. Co., East Chicago, Indiana, a division of the Union Tank Car Company. Mechanical engineering and foundation design for both structures was handled by Battey & Childs, Chicago engineers and architects.



Pipe and rod trusswork was used on first Union Tank Car dome erected at Baton Rouge, Louisiana site.

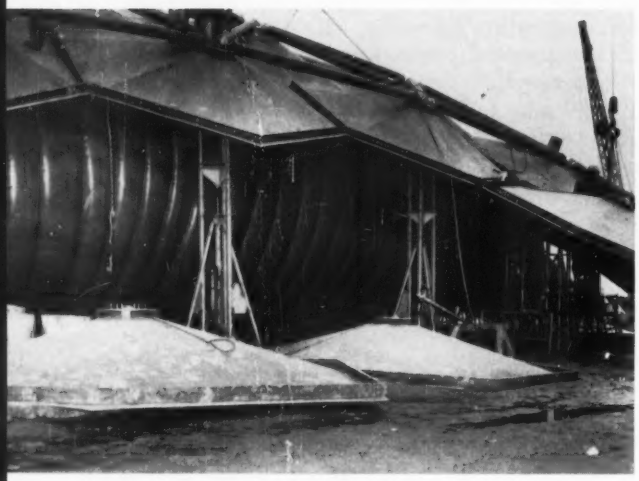
The Baton Rouge dome design uses standard 11 gauge sheet steel, 4-in. pipe, and 1½- and ¾-in. rod as structural elements, with each steel panel requiring several connections. At Wood River, the bill of materials consisted only of 6-in., schedule 10 steel pipe and the steel panels. Pipe connectors at the vertices of the panels allowed the pipe framework to be tied in as erection proceeded with simple welds. One measure of the success of this design is the 7 ton reduction in dead load achieved.

At Baton Rouge, the first of the two domes was erected from the base ring up, with cranes lifting panels into position for welding. At Wood River, the center top section of the dome was erected on a scaffolding and a vinyl coated nylon bag was cemented to the underside of the outer panels. The fabric was also hooked to an angle to facilitate removal. As a reinforcing measure, 326 ropes were also attached to the angle and run downward and around the bag to a holding ring in the center.

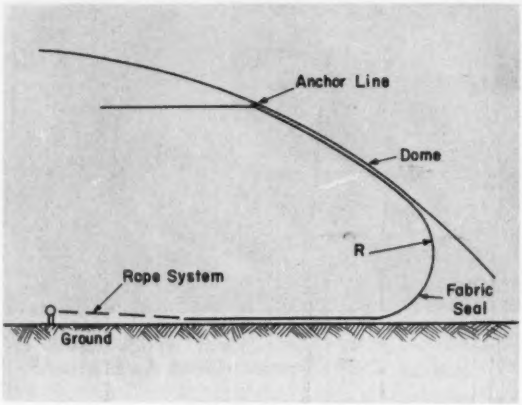
At this point the bag was inflated by a 25 horsepower blower feeding air through an underground tunnel running to the center of the dome. By means of a vent, internal pressures were maintained so that 90 percent of the dome weight was supported by the internal air pressure and 10 percent by jacks at the outer edges. When a ring of panels was attached, it required a pressure of only 1.6 ounces per square inch of dome to lift it to a higher position. Guy lines prevented side sway of the dome during lifts and high winds. While the top to bottom erec-

Second Union dome uses simple pipe truss. Though size was same as first dome, total weight was less.

At Wood River, top of dome, resting on scaffolding was built first, then balloon was inflated through the pipe.



Balloon supports 90 percent of dome weight while remaining 10 is carried by adjustable jacks at edges.



Supporting vinyl coated nylon bag is cemented to underside of dome and hooked to angle tacked to dome.

tion of geodesic domes with complete balloons has been used on smaller, lighter structures, the partial bag technique applied at Wood River is unique.

Since these two huge domes meet the ground at an angle considerably less than 90 degrees, there is a significant horizontal thrust component. At Baton Rouge, the foundation was designed as a tension ring, with concrete reinforced to adequately resist the induced tension. At Wood River, the horizontal thrust was taken by a steel plate tension ring resting on the concrete foundation and rigidly attached to it. The structural members of the dome and the skin itself were welded directly to this steel ring. In both installations, poor soil conditions required a supported foundation. At Baton Rouge, 80 caissons were set on 15-ft centers around the center line of the foundation. At Wood River, poured-in-place concrete piles were used.

Although the geodesic dome is not basically a load carrying structure, the design will permit suspension of such minor loads as utilities, accoustical materials, and insulation. If there are unusual concentrated loads, the dome can be designed to accommodate them. Suspensions were made on these domes from points of intersection of structural members.

Radial wireways are end supported on a continuous perimeter wireway which is in turn supported by brackets welded to the inside dome surface. Each radial wireway is suspended from a single bracket secured to the dome by means of several stainless steel cables, one attached to each wireway at a point above each light fixture. In order to stabilize the radial wireways, they are

Guy lines prevent sideway of dome while 326 ropes run around the nylon bag to a central holding ring.

Reinforcing bars are placed in foundation forms set on poured in place concrete piles spaced 15 feet apart.

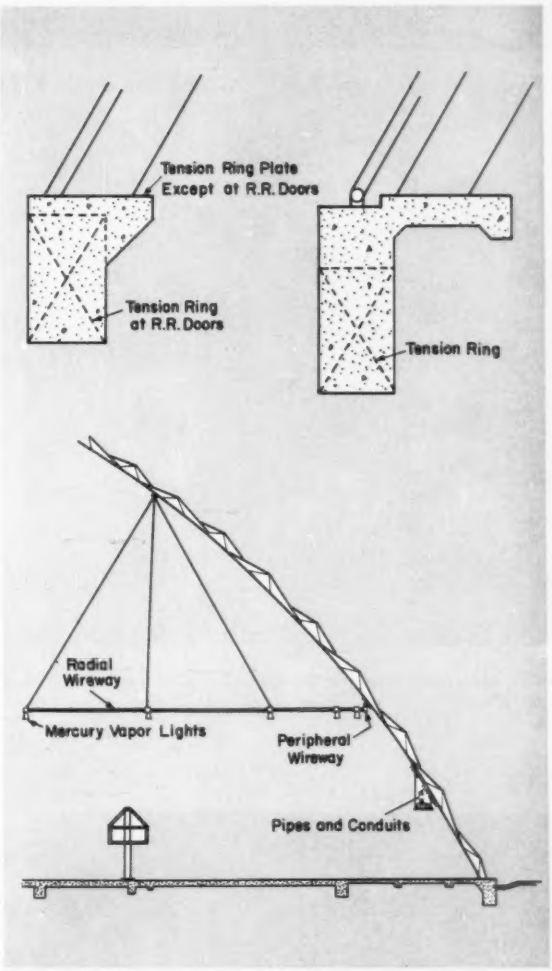
Hexagonal pyramids form the basic plate elements at Wood River. Note pipe connector fittings at each apex.

tied together at their inner ends by a steel cable draw string which puts them in tension. Mercury vapor lamps are suspended about 30 feet above the floor to form a 332-ft diameter circle of 106 color corrected mercury lamps. Although the lamps burn only 1000 watts, they provide 50 footcandles of light for all work areas. Additional lamps of this type with peach colored filters give the roof of the dome a warm appearance and provide some indirect lighting. The lighting system was designed by Abe Feder.

Since most of the shop and repair operations are around the perimeter of the dome, all piping utilities are run in a continuous circumferential loop. Electric power is also run along the perimeter to panels located in the various shop areas. These conduits and pipes, suspended from unistrut channels secured to brackets welded to the dome valleys, are located in a band above the heads of doors.

Ventilation in the Union domes is provided by a large gravity ventilator at the center-top, with exhaust units for certain processing areas. Air velocities within the dome are quite low except near openings.

Because of the 116-ft height of the domes, it was necessary to devise some means of servicing without the erection of extensive scaffolding. The problem was solved with short pipe sections installed at frequent intervals at the peak of the pyramids in the dome skin at Baton Rouge and at every peak at Wood River. The pipes are capped to provide a weather tight surface when not in use, but are readily available for suspending work platforms.



Foundation details, Wood River dome left, Baton Rouge right. Piping and wiring lines located on perimeter.

Geodesic Domes in Aluminum

The Kaiser aluminum geodesic dome is a stressed skin design, developed by the company's own engi-

First of the Kaiser aluminum, stressed skin geodesic domes was erected in this tropical garden setting in Hawaii.

The Moscow dome, widely reported, also was designed by Kaiser, with sheets sheared and braked in Russia.

Citizens State Bank in Oklahoma City is aluminum dome mounted on a circular concrete and glass exterior wall.

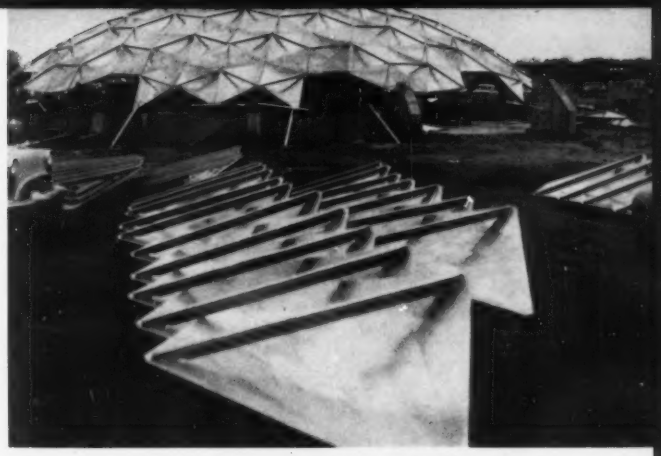
neering staff to take advantage of the unique physical properties of aluminum. Basic ocnstruction panels are diamond shaped, with a bend pattern designed to give maximum structural performance. Available in six standard models, the domes range from 99 to 199 feet in diameter. Actually, there are three sizes in each of two designs, one based on an inner sphere radisu of 80 feet and the other on 112 feet. In the smaller size group, the dead load of the structure is 1.9 pounds per square foot, in the larger, 2.4. While these dome structures have been rather completely engineered and standardized, and others are under development, the Kaiser engineering group has as its main objective the development of new structural design techniques for aluminum.

The first Kaiser dome was erected in Hawaii, but the best known is probably the 250-ft diameter, gold anodized unit which proved to be the center of attraction at the United States exhibit in Moscow. An interesting sidelight is the fact that the aluminum panels for this dome were shipped to Russia in sheet form and sheared and braked on the job site. Structural elements are fitted together with lock bolts, using a special fitting at the meeting of the diamond points and flanges along the edges.

Diamond panels in the Kaiser design vary in size, nine different sizes being required for the smaller

dome series and 14 for the larger. Panels are fabricated with aircraft precision, tolerances being maintained to ± 0.005 inches in a length of 10 feet. The heaviest diamond panel weighs only 65 pounds, an important consideration during erection. The domes are usually erected from the top down, with the progressively enlarged surface being hoisted up a central tower so that construction activity is always under way at ground level.

The first balloon lifting technique was successfully used on what was also the first factory dome structure, located at Abilene, Kansas. A 145-ft diameter dome was completely erected in only 22 working hours by a 38-man crew. The system employed a smaller balloon resting on top of a larger one, with cables rigged from eye bolts in the concrete floor to steel channel bars tied around the sides of the balloons.

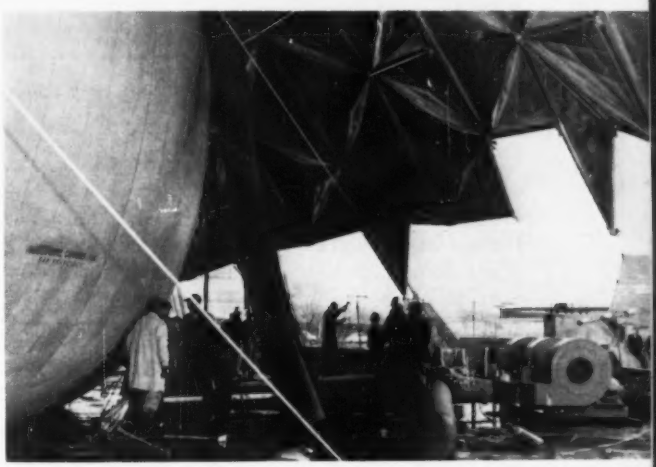


Industrial dome structure is balloon supported during erection. Note the prefabricated diamond shaped panels.

Other Geodesic Domes in Metal

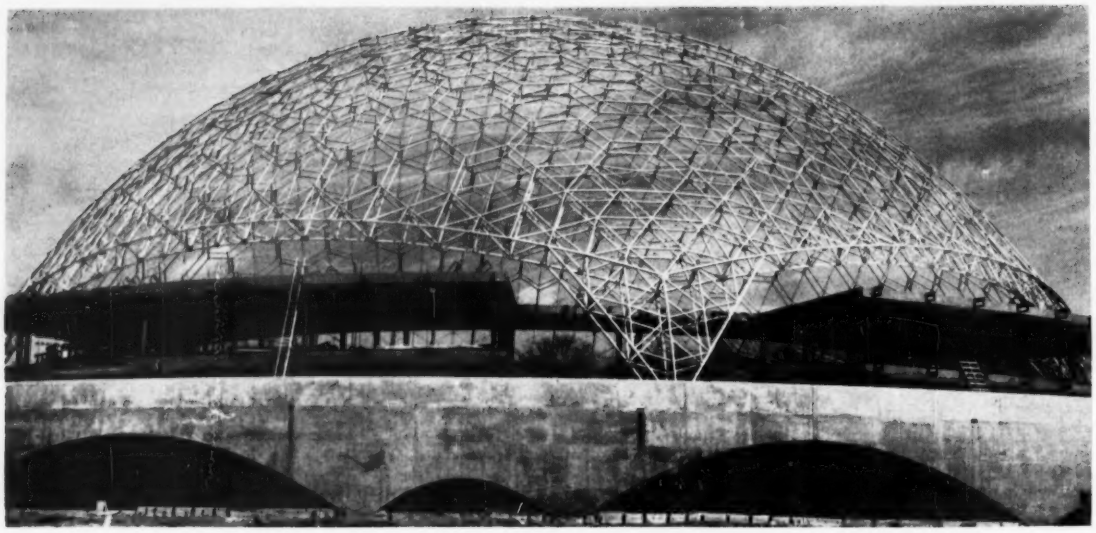
Actually there are a large number of geodestic dome fabricators and designers, most of them working under Fuller licenses. As a part of the new American Society for Metals headquarters, Gilmore-Olson, engineers and builders, incorporated a large geodesic trussed space frame which was fabricated by North American Aviation. It is a true truss design with frame members lying in two distinct spherical surfaces and tied together by cross members meeting at a central point from the vertexes of parallel hexagons. A similar structure is being fabricated now by North American for the famous Shaw's Garden, in St. Louis. This dome will span 175 feet and will have a Plexiglas surface.

One of the most interesting geodesic dome applications was that specified by Smith & Gillespie,



Small blower maintains a balloon pressure sufficient to support dome at a convenient construction level.

Completed dome structure is the first to be used for an industrial plant and also the first to use balloon erection.



Geodesic space frame is part of the new ASM building. Structure was fabricated by North American Aviation.

consulting engineers, in Jacksonville, Florida. Hydrogen sulfide gas escaping from the trickling filter surface at a Florida sewage plant was creating a serious public nuisance. To eliminate it, the consultants recommended a geodesic structure with a suspended Dacron baffle to cover the filter. The fabric, weighing only 3.4 ounces per square yard, is woven close enough to trap the fumes which are then discharged through a high stack.

The supporting dome is 112 feet in diameter and 27 feet high. It supports the Dacron fabric at 500 points, and no effort is made to seal the dome, since the fabric is taut enough to let water run off freely. The fabric is protected against damage from sun and falling objects by the dome, and the dome is in turn protected from the corrosive gases by the fabric. The dome is the concept of Jeffrey Lindsay and Associates. Components were produced in California, the complete shipment making up half a load for a standard trailer truck. The 47 aluminum panels and the stainless steel truss were erected in under a month by seven men.

Sewage disposal plant uses a geodesic dome structure to trap noxious odors rising from the trickling filters.

Dacron lining suspended from dome is protected from external damage and prevents corrosion of dome surface.

Dome Structures...

Designs in Concrete

Concrete shell dome covers 2.25 million gallon water reservoir and successfully resists water pressure at 7½ feet above spring line.

THIN SHELLED CONCRETE dates back to about 1910, but its real impact in the United States, except for water tanks, is of fairly recent vintage. In spite of high form costs, thin shelled domes offer pleasant appearance, smooth surfaces, structural rigidity, and negligible maintenance costs. The attack on high form costs is being pursued with good results. Solutions involve segmental pouring, spraying, making forms a part of the finished structure, prestressing and pre-casting of segments, and using shaped mounds of earth for formwork. Depending on specific job site conditions, many of these solutions have resulted in significant economy.

A good example of the shell dome applied to a 2.25 million gallon water reservoir is that designed by James D. Caulfield for Carl E. Green & Associates. It is located just outside Portland, Oregon, and is a part of the West Slope Water District.

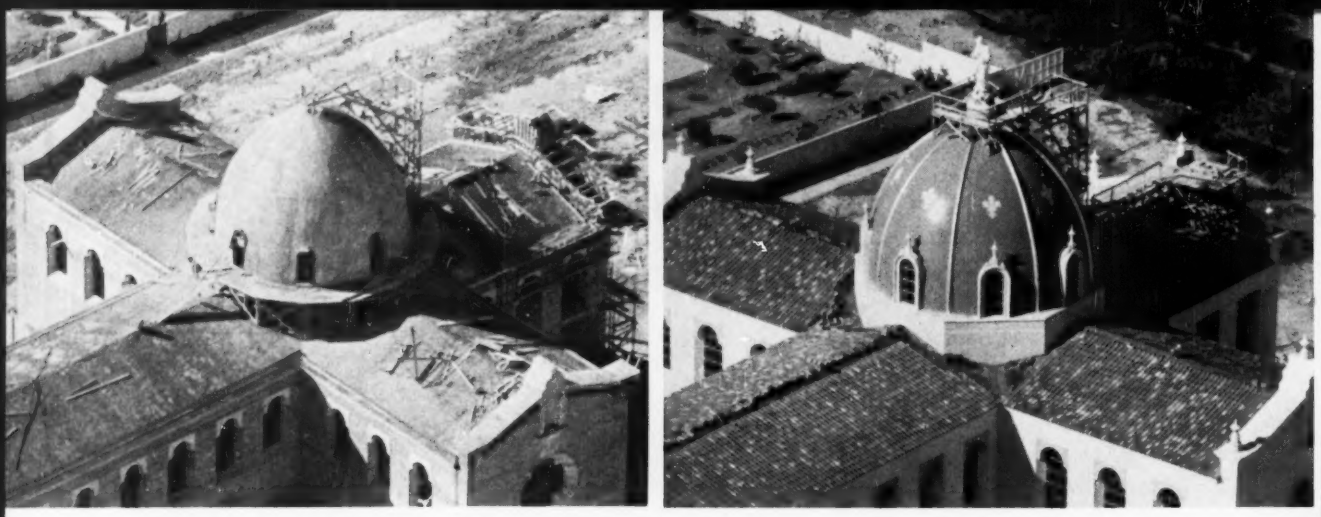
The dome design is in conformance with methods recommended by the Portland Cement Association, modified to provide for internal hydrostatic pressure. It is 120 feet in diameter, with a 15-ft rise and a water surface rising 7½ feet above the spring line. Minimum thickness where it joins the wall is 22 inches. Low unit stresses in the dome match those in the wall, with 14,000 psi in the steel and 300 psi in the concrete. Except for the central access hatchway, the dome was poured as a unit.

In some designs for similar structures, insufficient attention has been given to the avoidance of direct load and shrinkage hairline cracks in hydraulically loaded concrete structures. Cracks are not only unsightly, but may permit leakage. In this structure the designer used the simple expedient of increasing the thickness of the structure until a safe allowable unit tensile stress for concrete was reached.

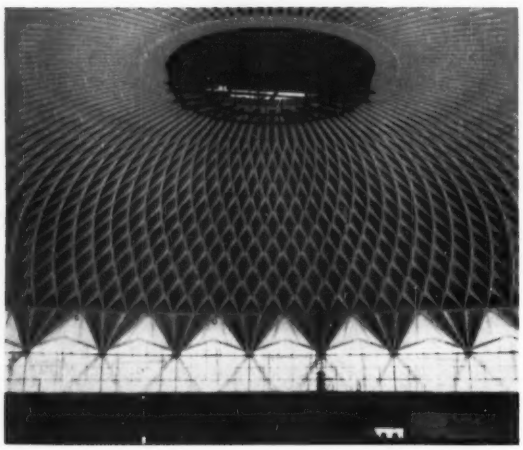
Gunniting of domes is now a well established technique. An interesting application of this method was used on a small dome for the Immaculata Chapel of the University of San Diego, designed by structural engineer John Ruskin.

The 40-ft diameter dome rests on an octagonal wall which is supported by four reinforced concrete columns tied together by beams. Scaffolding on the inside was used to support the plywood forming for the dome. The gunniting operation was facilitated by a three-level, revolving scaffold which pivoted at the center and moved on wheels.

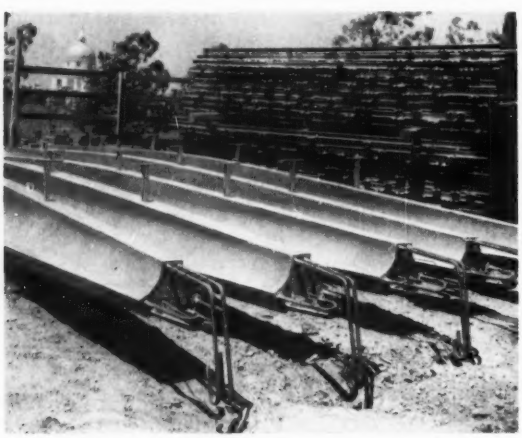
It was planned to waterproof the concrete surface, which is overlayed by ceramic tile, with a non-



Gunnited thin shell concrete dome is overlayed with ceramic tile on grouted wire mesh over building paper.



Interior of Nervi's small Olympic Stadium is a graceful pattern of curved precast reinforced concrete members.



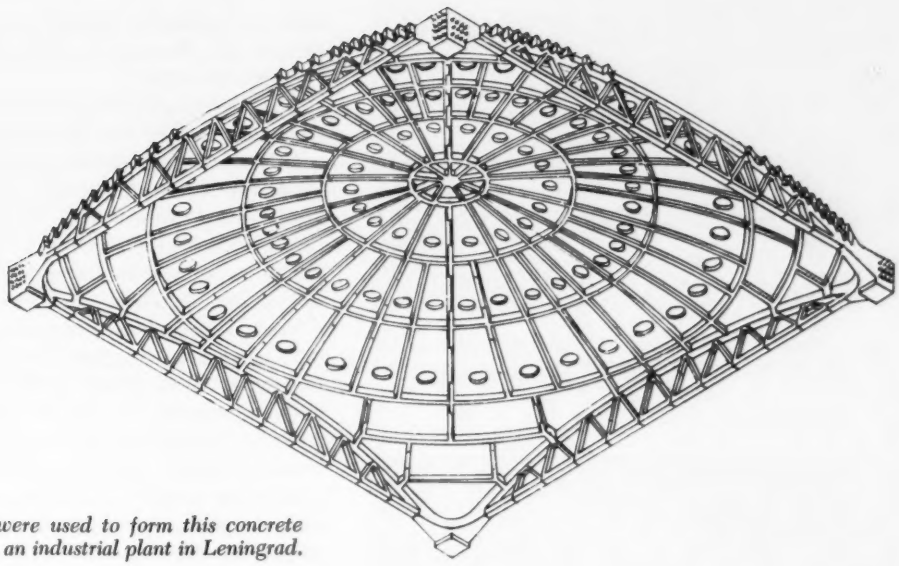
Precast concrete elements such as these are used in Nervi designed dome structures to eliminate formwork.

hardening mastic. However, since this nonhardening characteristic was hard to find, the final decision was to use building paper and wire mesh with no fastening into the concrete shell. The grout base and tile were set directly over this layer. The interior of the dome was covered with a ¼-in. layer of bituminous base, crushed cork composition to prevent condensation. Approximately 85 percent of the interior was tiled for acoustical reasons.

The use of precast concrete in domes is a technique not common in the U.S. It has been used effectively by Nervi, in Italy, for example, on the Olympic Stadium. This structure, in particular, is extremely graceful in interior appearance, the roof members being exposed to form an interesting pattern. Not so beautiful, but quite practical, is the domical roof design used by the Russians to cover the area between two factory buildings outside Leningrad. Formed of 135 precast elements of 16 different types, the two shells are 131 feet square. The shell itself is 4 inches deep, ribs 10 inches deep.

The entire shell, weighing 560 tons, was assembled on falsework at ground level by welding, grouting, and prestressing. It was then lifted to a position slightly above its permanent height, and precast hollow core column segments 2 feet square by 3 feet high were erected in place and the shell lowered onto them. Each of the four edges of the shell is supported in a vertical plane by a shallow truss made of precast elements.

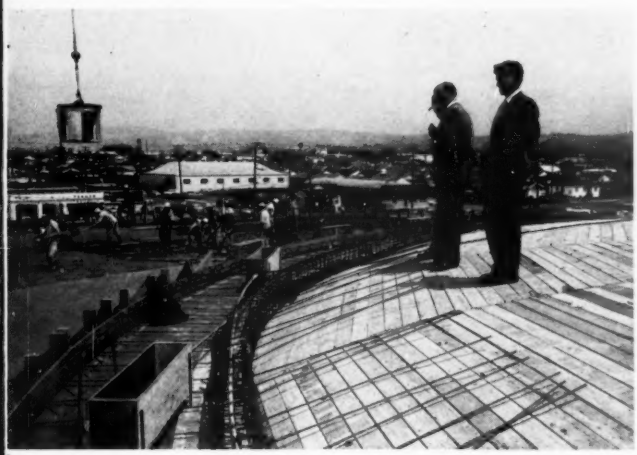
An interesting post-tensioned edge beam design was used by Dalton and Dalton, consulting structural engineers, on a building for the San Leandro Unified School District in Alameda County, California. The architects, Schmidts, Hardman and Wong, had decided on a circular building, and a reinforced concrete shell dome seemed the logical answer for covering the library at the core of the building.



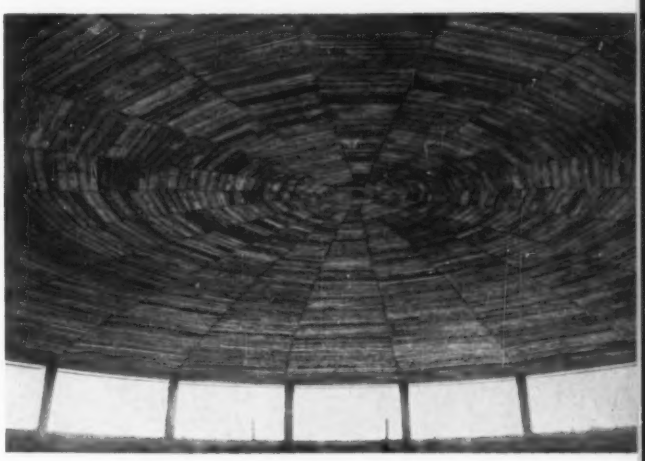
Precast elements were used to form this concrete shell dome used at an industrial plant in Leningrad.

However, the dome was to be supported on a ring of 10 by 12 inch mullions, spaced 10 feet apart on a circle 61-ft 4-in. in diameter. The 4-ft high mullions provided for a strip of clerestory lighting under the periphery of the dome. Unfortunately, the tangential thrust developed by the dome was found to be of sufficient magnitude to overstress the mullions in bending. To meet these architectural requirements, it was decided to post-tension the edge beam to counteract the tendency of the dome to spread when it took its load after form removal.

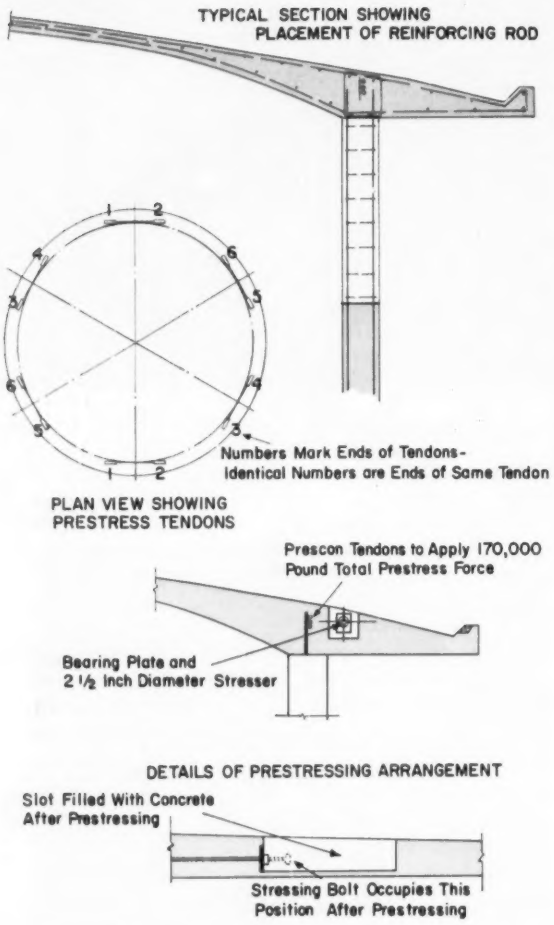
Three pairs of tendons were cast into the concrete edge beam, each making a complete circular loop. Tendon ends were staggered 120 degrees to provide a uniform stress distribution throughout the full circumference. Eight ¼ in. cold drawn wires made up each tendon, giving a working force per tendon, after losses, of 56,700 lb. The tendons were enclosed in a slippage sheathing and ends were located in rectangular pockets cast in the concrete edge beams. Approximately two weeks after concrete was placed, when it had reached a 3000 psi strength, the tendons were tensioned. A system of tension, relax, and re-tension was used to iron out the high and low stress peaks caused by friction from both curvature and wobble effects. One man



Box in the foreground contains screw takeup for tendons used in post-tensioning the concrete shell roof.



Dome was prestressed after concrete had reached a strength of 3,000 psi. Tensioning took one man day.



Prestressing details show use of screw type takeup.

day was required for this operation, following which forms were removed. There has been no observable vertical deflection.

The Albuquerque Civic Auditorium, also a post-tensioned shell dome structure, is interesting not only because of the unusual post tensioning method used, but because the dome was constructed over a temporary earth mound. When the concrete had properly cured, the earth was removed, leaving the 218-ft diameter dome resting on 22 columns equally spaced around the circumference.

Fred J. Fricke, consulting structural engineer, reports that conventional reinforcing placed in the ring beam of the dome served three functions. The radial reinforcing served to strengthen the outer areas of the shell as the ring beam gradually assumed the shape of the 5-in. shell. The longitudinal reinforcing served to reinforce the ring beam as a ring column as the dome lay unloaded on the earth mound and received a 1.8 million pound compression load from 840 turns of No. 8 wire wrapped around the ring at an initial stress of 140,000 psi. The longitudinal reinforcing also gives an added structural strength factor to the turns of the wire added after removal of the earth mound. Stressing wire was applied by means of a tractor-drawn capstan wheel and braking machine that traveled the circumference on a specially prepared roadway. The length of wire totaled 85 miles. The 24-in. deep ring beam is relatively shallow since much of the dome load is transferred directly to the columns.

Carl R. Albach, electrical engineer for the Albuquerque structure, points out that lighting created a problem because no conduit could be re-

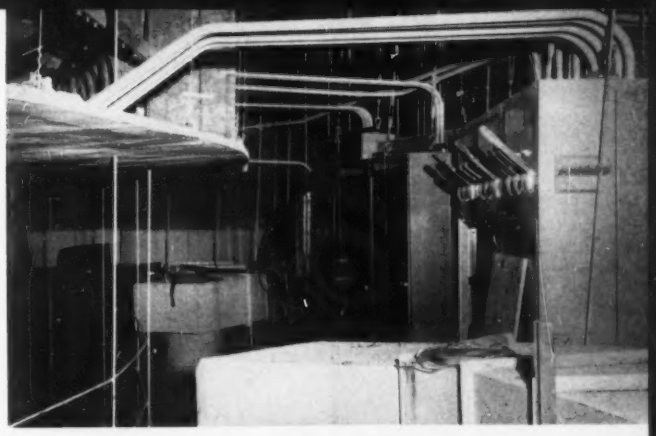
Albuquerque Civic Auditorium dome was poured on mounds of earth. Tops of buried columns can be seen.

Shallow ring beam of dome is only 24-in. deep and was prestressed with 85 miles of wire applied by tractor.

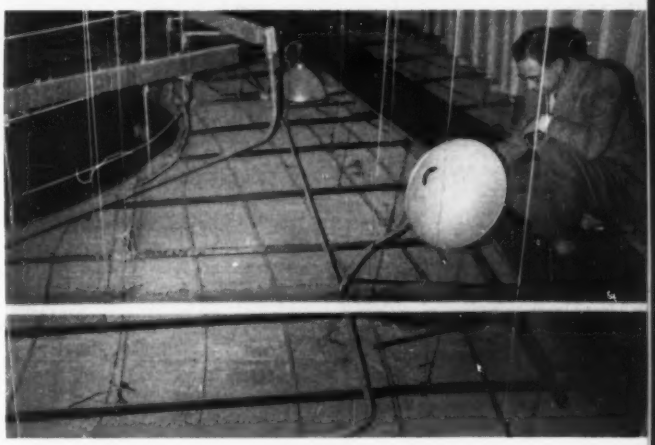
cessed in the roof construction. Confined to the curtain walls and columns, it was at first hoped that indirect lighting from column-mounted fixtures would be adequate. Study showed it to be impractical, but at this point acoustical engineers specified the suspension of two large baffles from the dome. One is a 164-ft outer diameter ring, with a circular surface above its central opening.

Though designed primarily for their acoustical properties, the baffles served also to solve many other problems by providing support for downlights, lighting switchboard, dimmer boards, sound console, speakers, air diffusers, and stage lighting plugs. Downlighting from the baffles consists of three concentric rows of 24 high-bay, aluminum type reflectors with 750 watt incandescent lamps recessed into the lower baffle. Total lighting from the baffle supplies up to 30 footcandles.

The air conditioning system, designed by Dr. Marcello Giomi, consists of a single 271-ton steam absorption refrigeration unit. Equipment is located in a mechanical room in a penthouse above the lobby next to the dome. There is adequate baffling to prevent sound transfer. The main auditorium receives 93,000 cfm of air through ceiling diffusers mounted in the acoustical baffles. Air is relieved through the lobby, where supplementary heating and cooling is provided through radiant coils in the floor. This takes care of air conditioning the stage area. From the lobby, air is returned to the air handling system, with part of it exhausted through the mechanical room for ventilation and for supplying air to the cooling towers which take advantage of the lower wet bulb of the exhausted air.



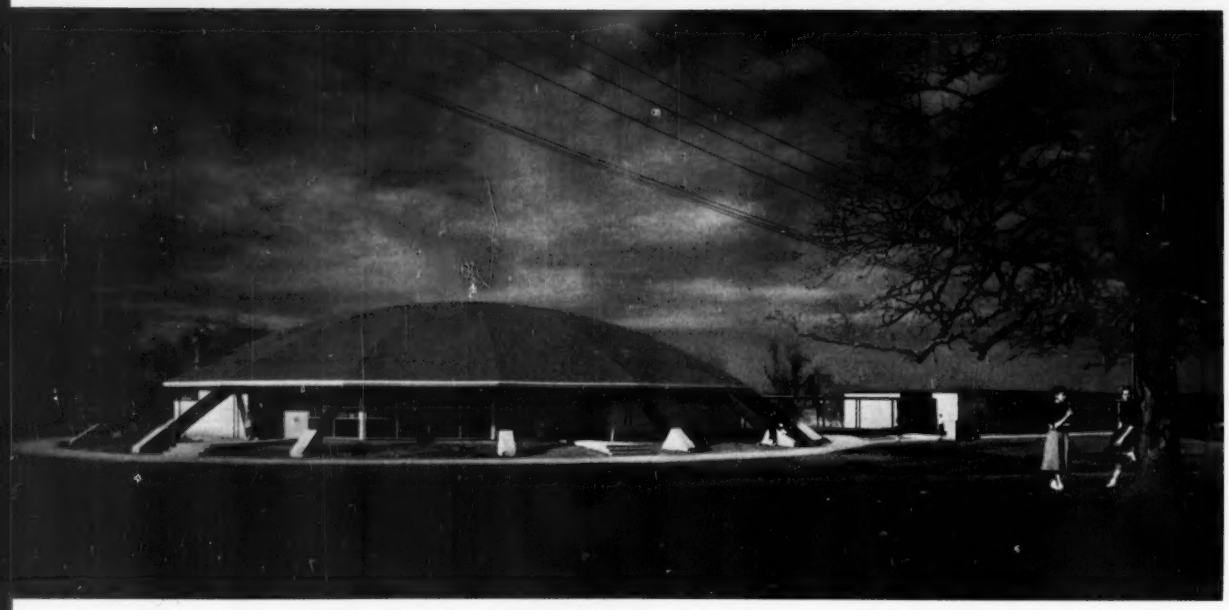
Manually and electrically operated dimmer boards hang from the dome and are concealed by acoustic panels.



Ring of downlights, a catwalk, and a plug-in strip are located on lower acoustic baffle for easy accessibility.

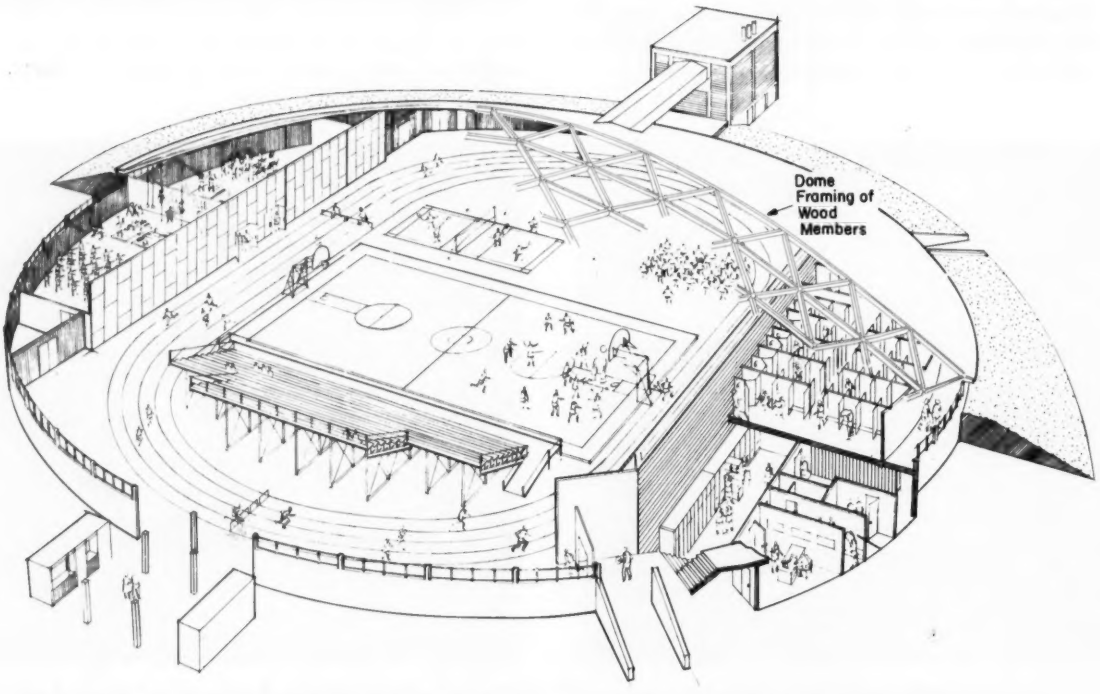
After concrete had cured and prestressing was completed, the earth was excavated from under the dome.

Finished interior of arena shows ceiling lights and ventilators. Air conditioning ducts appear in the opening.



Laminated timber arches support the domed roof of the high school auditorium at College Station, Texas.

Dome Structures . . .
Designs in Wood & Other Materials



A grid of 4- by 14-in. laminated timbers forms the domed roof of this Wayland, Massachusetts gymnasium.

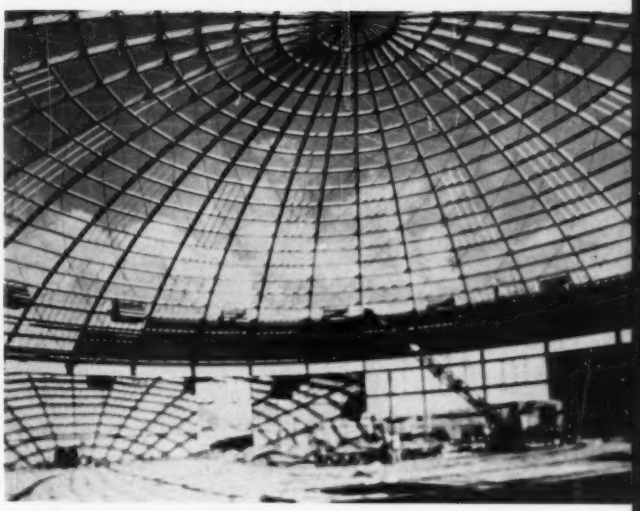
DOMES OF WOOD and other materials, while presently a minority group, cannot be discounted or ignored. With the growth of wood technology, particularly lamination, structural members of wood are available to meet a wide variety of conditions. Wooden domes are quite popular in school construction for use as auditoriums and gymnasiums, and they have proven quite economical. Other materials for domes include the whole range of plastics and even corrugated paperboard. Much of the work involving these materials is experimental, but the United States Marine Corps is presently replacing its conventional tents and shelters with geodesic dome structures having metal frames that suspend coated fabrics.

The A & M Consolidated High School at College Station, Texas, has a domed auditorium supported on laminated timber arches which cost $10.37 per square foot, less than the cost of the classrom section of conventional steel framing. The architects, Caudill, Rowlett and Scott, recognizing the acoustical imperfections of the dome shape made early plans to meet acoustical requirements by hanging acoustical ceilings and constructing a serpentine interior wall of wood. The result is a successful compromise between structural shape and functional requirements. A. M. Martin was the structural engineer, J. W. Hall did the mechanical-electrical work.

One of the newest timber domes is that designed for the Wayland, Massachusetts, Senior High School. The Architects Collaborative, working with consulting engineers Souza and True, have specified a 209-ft diameter dome design which utilizes a grid of 4- by 14-in. laminated wood members with a deck of 2-in. tongue and groove plank to tie the truss members into a rigid system.

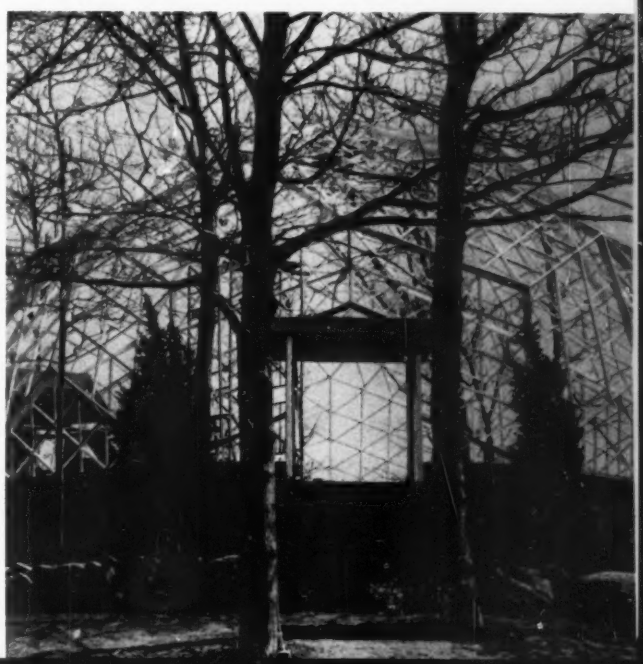
The dome, housing an area for a complete physical education program, is truly spherical, with each laminated wood roof member a segment of a great circle. Thus, each piece has the same radius of curvature although lengths differ. The roof structure is supported on short lally columns atop a concrete wall, with thrust taken by a steel tension ring made up of plates and angles. The ring is set on Lubrite plates atop the columns to allow movement resulting from temperature changes. Connection between the dome frame members is through bolted steel plates and pipe. The remainder of the dome structure is either laminated wood or standard sizes of sawn lumber.

The Mount Calvary Church, in Cuyahoga Falls, Ohio, uses laminated timbers in a triangular pattern for its dome spanning over 220 feet. Hand winches



World's largest wooden dome spans 300 feet at Montana State College fieldhouse located at Bozeman.

Calvary Tabernacle at Cuyahoga Falls, Ohio, spans 220 feet with a triangular grid of laminated timber.



Geodesic dome of wood members covered by clear plastic is used as restaurant at Woods Hole, Massachusetts.

Pease Woodwork Co. manufactures these small domes of plywood for use as garages or utility buildings.

The Berger Brothers Co. uses geodesic design for its air inflatable dome of neoprene coated nylon fabric.

and gin poles were used for the entire erection job. Two-inch tongue and groove sheathing was installed over the dome members.

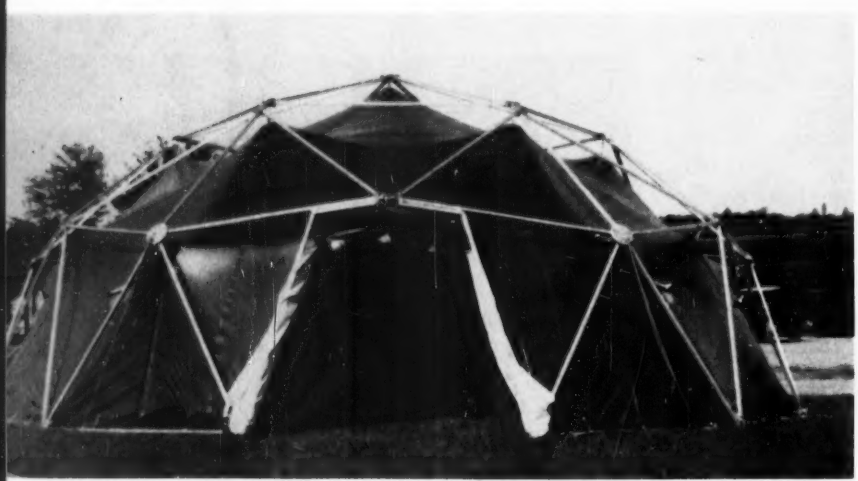
The world's largest timber dome is a 300-ft diameter laminated rib structure with a rise of 50 feet. Consulting engineer for the job was Ben F. Hurlbut, the architect Wilson and Berg. It is located at Montana State College, in Bozeman.

Erection of the dome was completed in three stages, an outer ring was first framed on shoring poles, then a second ring, and finally the third ring was tied into the compression ring mounted on a temporary tower. Arch ribs connect on the bottom to a heavy box section tension ring at 10 degree intervals. Nineteen rows of glued laminated purlins extend circumferentially around the dome, spaced at eight feet. The dome was fabricated by Timber Structures, Inc.

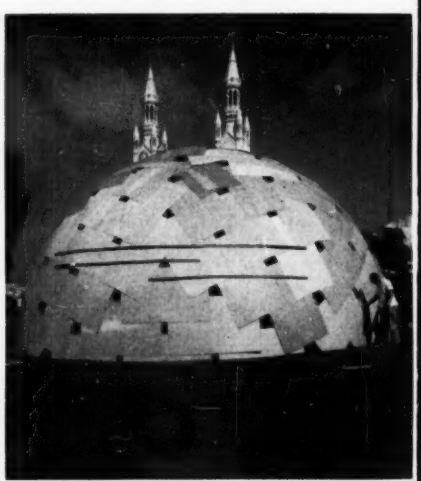
While dome structures are getting bigger and bigger, they are also getting smaller. There is now a wood, plastic, or paper dome garage for every backyard. They can be blown up, nailed up, bolted up, and some will even put themselves up.

In contrast, there is the 525-ft diameter dome, in the planning stage, for a shopping center in Montreal. And, even bigger, is Fuller's dream of a 2-mile diameter dome over the heart of Manhattan — a lacelike weaving of aluminum framing closed in by a clear plastic skin.

After that, spheres in space! ▲▲



Marine Corps shelter, manufactured by Magnesium Products of Milwaukee, Inc., uses metal frame which can be easily disassembled and stowed.



Shell Structures, Inc. uses plywood sheets to form dome.

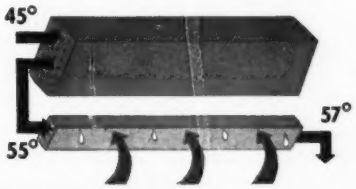
When classrooms require Air Conditioning

to maintain the proper thermal environment . . .

Nesbitt
YEAR-ROUND
SYNCRETIZER

Exclusive Precooler

WHAT IT IS . . . WHAT IT DOES



The Nesbitt Precooler is a *second* cooling element. It uses water that has already cooled the main cooling element to cool and dehumidify outdoor air, increasing the capacity of the Year-Round Syncretizer by 15% to 30%. Consequently, for the same cooling load, the Year-Round Syncretizer uses smaller water quantities. This permits the use of smaller, less expensive pipes, insulation and fittings. In fact, piping can be wall hung to eliminate costly trenches, crawl spaces and runouts. In addition, pumps and chillers are smaller, less expensive to install, more economical to operate.

Totally, the exclusive Nesbitt Precooler permits system savings of hundreds of dollars per classroom . . . and insures greater humidity control in warm weather.

When consulted about air conditioning for new or old educational buildings, the engineer can help the educator—and himself as well—by recommending the system that is tailored to school needs by the company with more than 40 years of specialization in that field.

The Nesbitt Year-Round Syncretizer is a unit system. Building spaces can be equipped selectively. Only the classrooms actually in use need be conditioned.

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Made and sold by John J. Nesbitt, Inc., Philadelphia 36, Pa.
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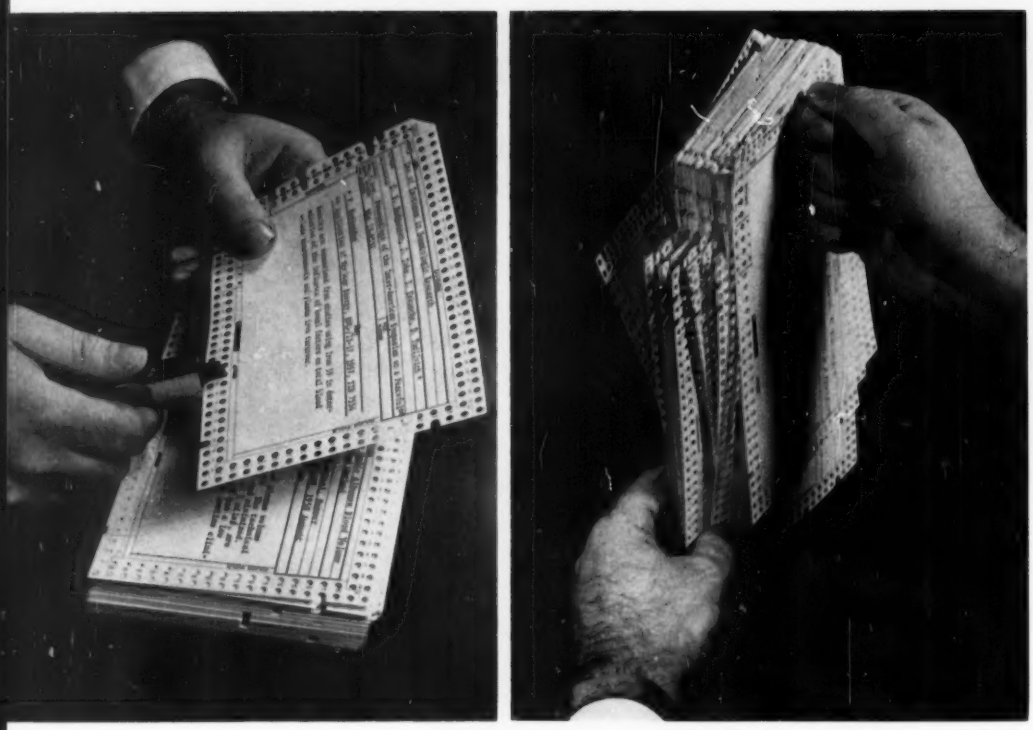


Hand punch and sorting rod are the only tools needed to process cards.

Finding Your Filed Data -- Fast

DANIEL I. WEINBERG, Astra, Inc.

Daniel I. Weinberg received a Bachelor of Electrical Engineering degree from Clarkson College of Technology in 1948. He was with the Aircraft Nuclear Propulsion Project of the U. S. Air Force and U. S. AEC until 1956, first as an engineer and physicist with Fairchild and later as senior engineer with General Electric, and he has been with Astra since 1957. In 1958, when Astra moved to the Research Triangle of North Carolina, he was asked by scientists at Duke Medical Center if he could assist them with some of the engineering problems encountered in their medical research. This work is now his major activity. He also conducts a course for the senior medical staff on the principles of instrumentation. He is a registered professional engineer in Ohio, Connecticut, and North Carolina, and a member of IRE, AIEE, and NSPE.

LOCATING TECHNICAL DATA has long been a major problem in science and engineering. At Astra the problem is aggravated by the wide variety of fields in which we provide consulting services. These range from nuclear reactor design to medical instrumentation, from heat transfer to radiation shielding. Although the basic principles in these diverse fields are much the same, we must be alert to the latest developments in many fields and to the side effects peculiar to each if we are to provide proper services to our clients.

CE exclusive

For example, nylon has many properties that make it a logical choice for some parts of certain instruments. However, some nylon contains a toxic plasticizer which may leach out if it is in contact with body fluids for extended periods. If a medical instrument is to come in contact with body fluids, this nylon should not be used in a wetted part. This

is just one small example of the type of information we must have at hand and readily accessible if we are to call ourselves qualified.

Punched Card System

Information flows into our office, as into all other engineering offices, through many paths, such as technical journals and reports, books, manufacturer's catalogs, and discussions with other experts. In addition, information is developed within the office.

However, almost anyone can collect a variety of data. The problem is to get the information into the hands of the person who needs it, when he needs it. To do this with a minimum expenditure of professional time, we have started using a punched card sorting system to locate these bits of information. For flexibility, and because we want to facilitate the use of the system at any time by anyone, we are using a manual sorting system – the Keysort System, by Royal McBee.

This sorting system has two advantages over a standard (nonsorting) card filing system. First, the cards can be randomly filed and still located quickly; and second, one card can be located under any of several categories or subjects.

The basic component in the system is a peripherally perforated card on which we have had a form printed to simplify its use for our purposes. Beyond this we need only a simple punch, a sorting rod, and storage cabinets.

What Is Put on the Cards?

We use this system to index (catalog, if your prefer) many types of information. There are technical articles that are important in their entirety. But there also are technical articles that are important because of some sidelight – perhaps only a footnote or small comment in the published discussion.

Some articles fit into both categories. In many instances, however, the sidelight could be in an entirely different field from the article itself, and no one would suspect from the title that this gem was in it. For example, the item about nylon appeared in the transcript of a paper by C. A. Hufnagel (Georgetown University Hospital, Washington, D.C.) entitled "Blood Pumps, Conduits, and Valves," published in the March 1959 issue of *IRE Transactions on Medical Electronics*, in a comment by a Dr. Salisbury commenting on a comment by a Dr. Gwinn.

We also use the punched cards to index parts of design drawings that may be applicable to future jobs. And we index special items in technical books and reports. We also index manufacturers' catalogs. In general, these need be indexed only for seldom used parts and materials although a complete index would assist a new employee who might want to know which manufacturers are thought highly of in this office.

Use of Cards

The system is a relatively simple but effective one. If the card is being used to index a technical article, the article's title, author, his organization, the journal name, and its volume, page, and date are written or typed on the first five lines (see page 127).

If the information about the article was obtained from a set of abstracts; e.g., Nuclear Science Abstracts, or Engineering Index (especially if a literature search is being conducted), then the abstract source and its number are inserted on line six. If the material is filed in the company files, its file number is typed in, also on line six.

The space below the title block (and the reverse side of the card if necessary) is used for a brief abstract of the article or for notes. Often the important (to you) information can be written out in enough detail to eliminate the need to refer to the full reference. If desired, small charts and diagrams can be pasted or stapled to the card.

If the card is being used to catalog a small but important item in an article or report, a short headline description of the item is inserted in the title block. The remainder of the card is filled out in the usual way. If the entire article is being cataloged, the important small item can be included on the article card and the card punched for both the article and the small item.

Locating the Card

There are 92 pairs of holes around the edges of the card. When a card is punched for a given category, the space between the hole representing that category and the edge of the card is removed with a punch. Then, when locating a card, a rod is inserted into the hole representing the desired category, held horizontally, and raised. The cards that have been punched for that category fall clear, and they then can be either eye sorted or further rod sorted for a subcategory.

At Astra we have set aside 17 pairs of holes for major fields, 29 pairs for divisions within these, and 23 pairs for groups within the divisions. In addition, we have 13 pairs for the initial of the author's name (both personal and corporate authors), eight pairs for the decade and year, one to indicate abstracts and bibliographies, and one for vendors' catalogs. Cards can be either single or double punched. When single punched, only the outer hole is punched. To double punch is to punch out both holes of a pair.

When a card is double punched, it will drop out if the deck is sorted for its single punched mate. However, in order to save holes for what we con-

sidered more important categories, we have permitted this sorting ambiguity to exist in the author section of the card. The card is single punched for authors whose last names begin with A, C, E, . . . Y, and double punched for B, D, F, . . . Z. Unfortunately, this ambiguity cannot be eliminated by a double sorting because the card might have been punched for both letters of a pair (The article might have been written by Smith and Thomas.)

Under some conditions, ambiguities can be eliminated by double sorting; i.e., the cards are first sorted for the outer holes. Those dropping out then are resorted for the inner hole, but only the cards remaining on the sorting bar are used.

We make this hole with a double meaning work for us when punching a date (decade and year). Here, just four pairs of holes are used to represent 10 digits. The holes are numbered 7, 4, 2, 1. These are punched as follows:

To Indicate	Punch
1	1•
2	2•
3	1 & 2
4	4•
5	1 & 4
6	4 & 2
7	7•
8	1 & 7
9	2 & 7
0	No punches

•indicates a double punch

When sorting for a number 1, 2, 4, or 7, the rod is inserted through the inner hole to avoid the avalanche which might occur if, when sorting for 1, cards punched for 3, 5, and 8 dropped out also.

We have selected 14 major fields thus far (general, biology and medicine, chemistry, criticality studies, engineering, health and safety, instrumentation, materials, fusion and thermonuclear, physics and mathematics, nuclear reactors, neutron cross sections, computers, and missiles and space). We also have reserved three additional spaces for expansion. These have been assigned "major field" numbers from 30 to 46 (rather than 1 to 17) because the cards were numbered before we had them over printed. Within each of these fields, divisions are numbered from 1 to 29. Each division has groups lettered from A to Z.

For example, under "Instrumentation" – 36 is "Nuclear and Radiation" – 8, and under this is "Gamma" – C. Thus, to locate all our cataloged articles on gamma detectors, we would first sort field 36, then division 8, and then group C. If desired, we also could sort group E for scintillation counters and group M for counters used for medical applications. We then would have only cards indexing material dealing with: instruments, nuclear and radiation, gamma scintillation counters, used in medicine. If we wanted only the most recent references, we additionally would sort for date, and if we wanted a vendor's catalog, sort for that. Or, if we wanted an article on some special equipment built at Los Alamos Scientific Laboratory, we would sort under "Author" – L to separate out the cards in that particular category.

Setting Up a Classification System

The classification system used within a particular firm depends on the work done by that firm. Perhaps the easiest way to set up a classification system is to keep cards handy, filling them out whenever you come across information you want to be able to locate again. Then, when a number of cards are filled out, sort them into logical categories and (with a little thought to the future) use these as major fields.

As the number of cards in a major field grows, the field can be divided into divisions, and the divisions later divided into groups. The extent of these subdivisions and groups depends on the firm's special needs.

We have found it simplifies the system to use letters in the "group" subdivision when classifying materials. These are listed by the first letter of the material name. If it is a generic term, such as plastics, we double punch, if a specific material like carbon, we single punch. If a reference applies to more than one material, it is punched for each.

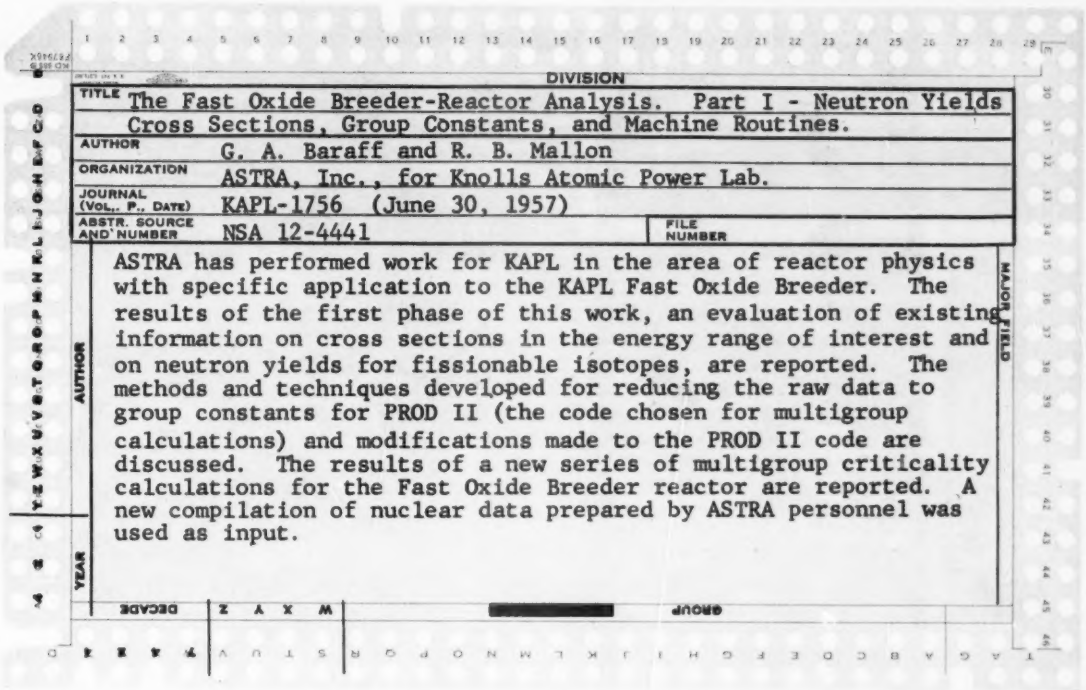
Accumulating a Card File

Perhaps the most difficult work in setting up a usable card file system is getting the cards filled out and punched. There are two ways in which the cards can be prepared. The first is the "one at a time" method. You come across an item you want to be able to refer to later, so you fill out a card for that item, punch it, and file it.

The other method is the "major effort." It is often necessary to conduct a literature search while working on some project. Instead of listing the fruits of that search on sheets of paper, put it on cards. These are then punched and filed. Since several cards can be punched at a time with a hand punch, this chore is not too time consuming.

In some fields – for example, electron microscopy – sets of printed and punched cards are issued periodically and can be purchased. These index the latest literature. One also can subscribe to the Engineering Index Service. It supplies printed index cards, for filing. These are not punched, however, and must be stapled or pasted to punched cards to fit them into this system.

One way to encourage use of the cards is to make them available to employees for their own personal


DIVISION
TITLE The Fast Oxide Breeder-Reactor Analysis. Part I - Neutron Yields Cross Sections, Group Constants, and Machine Routines.
AUTHOR G. A. Baraff and R. B. Mallon
ORGANIZATION ASTRA, Inc., for Knolls Atomic Power Lab.
JOURNAL (VOL., P., DATE) KAPL-1756 (June 30, 1957)
ABSTR. SOURCE AND NUMBER NSA 12-4441
FILE NUMBER
ASTRA has performed work for KAPL in the area of reactor physics with specific application to the KAPL Fast Oxide Breeder. The results of the first phase of this work, an evaluation of existing information on cross sections in the energy range of interest and on neutron yields for fissionable isotopes, are reported. The methods and techniques developed for reducing the raw data to group constants for PROD II (the code chosen for multigroup calculations) and modifications made to the PROD II code are discussed. The results of a new series of multigroup criticality calculations for the Fast Oxide Breeder reactor are reported. A new compilation of nuclear data prepared by ASTRA personnel was used as input.
AUTHOR
YEAR
MAJOR FIELD
DECADE
GROUP

Standard cards are purchased and then overprinted to fit the particular requirements of this sorting system.

files. This way the specialist in each field has most of the information on his specialty at his fingertips, and he has a real interest in making his file complete. Yet the file is available to everyone.

Characteristics of the Cards

The card which appeared to meet our requirements the best is Royal-McBee's number KD 585B. This is a 5" x 8" card with a double row of holes around the edges. It comes printed with numbers 1-46 around two edges, letters A-Z on the third edge, and some chemical symbols on the fourth. Since their printing is in brown, it is easy to overprint, in black, our own special code requirements. We could not get the perforated cards unprinted, and the Royal-McBee price for printing 1000 cards was higher than having a local printer do it.

Additional Materials and Equipment

We also purchased a punch. This special punch extends the hole to the card edge more neatly than does a standard hole punch. Another useful gadget is a book of repair stickers for use when a hole is punched by mistake.

For sorting, Royal-McBee supplies (for a fee) a sorting bar and alignment block; for a large scale operation, it is possible to get a gang punch and a mechanical sorter.

Some sort of card storage is needed. If cards are to be kept by individuals, then a small file box is convenient for use on a desk. If they are to be kept in a central file, larger cabinets will be required.

Costs

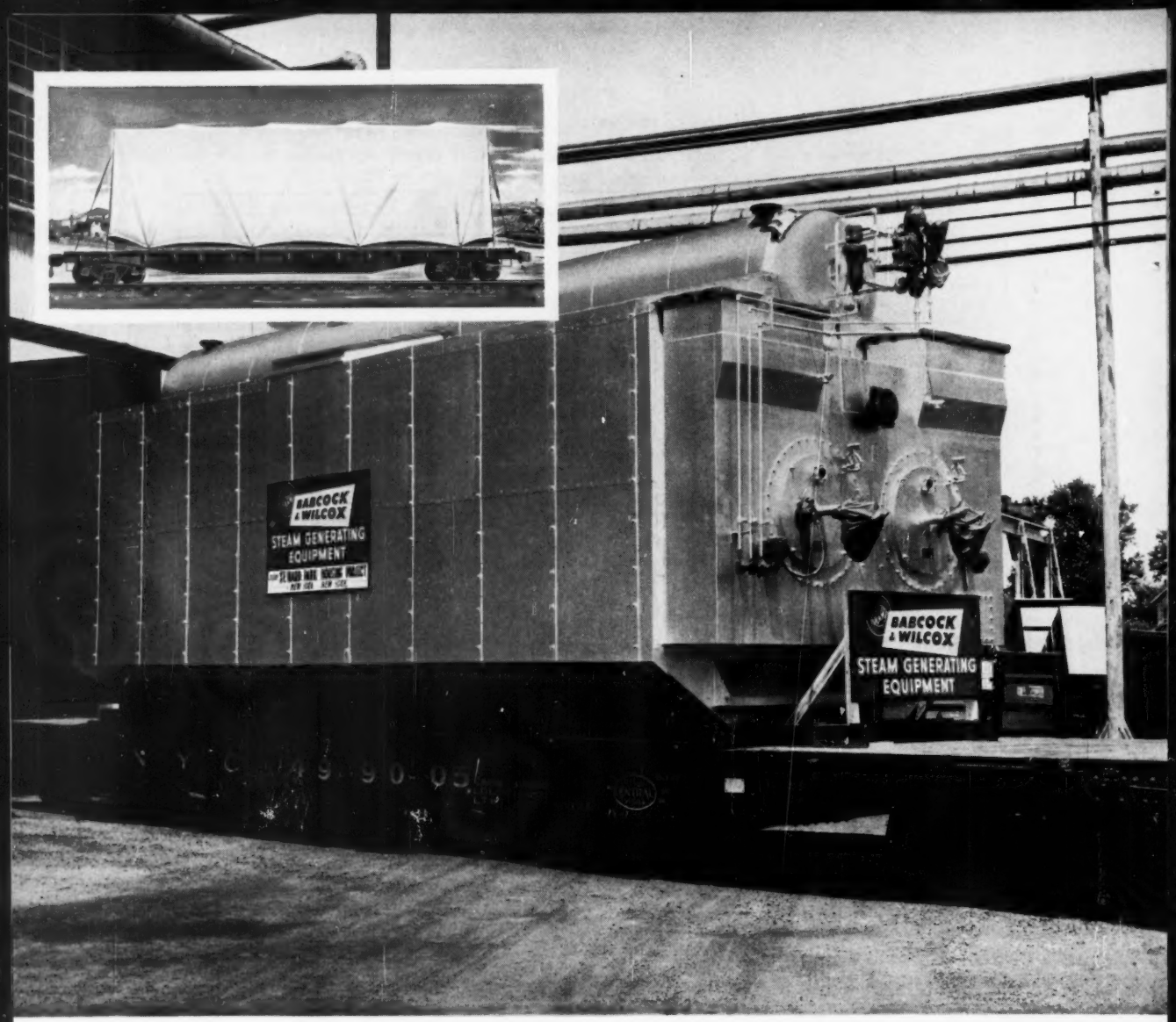
The approximate cost of installing this system at our firm with 1000 cards was:

Cards	$47.00*
Punch	7.25
Printing	20.00*
Sorting Rod	3.85
Alignment Block	3.30
File Box	5.00
Total	$86.40

*5000 printed cards cost approximately $200

Conclusion

This system, like any catalog, requires a certain amount of work to get it started and to keep it up. Some persons are naturally methodical and enjoy maintaining files of even the most difficult type. Others rebel against any attempt to channel their efforts and refuse to participate in even this simple card index system. (They claim they can remember all necessary references — and some can!) There are, however, many persons making up a middle group. They like to have the convenience this index offers, and they will, with a little encouragement, do their share in filling out the cards. It is for this group that this system is really useful. ▲▲



Now: The Wraps Are Off

B&W's FO Package Boiler

This shop-assembled B&W FO Package Boiler—being shipped as a single unit—is on its way to handle an important job.

The FO Boiler will supply all the steam to heat a new $22 million, 1728 family cooperative apartment house in New York City. Simplicity of installation is only one of the FO Boiler's attractive features: just remove it from the flatcar or truck, make the necessary connections, and start it up.

This natural circulation boiler delivers up to 100,000 lb of steam per hour. It's B&W designed, to give you reliable high capacity with minimum maintenance in a small space. If you have a problem involving steam, B&W—with nearly a century of experience in the design and manufacture of steam generating equipment—will be delighted to help you. Just write to The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

G-951-1B

B&W

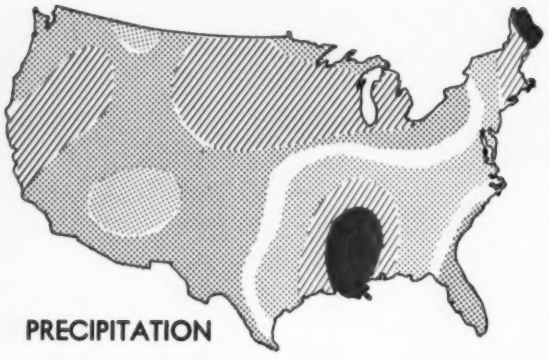
THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

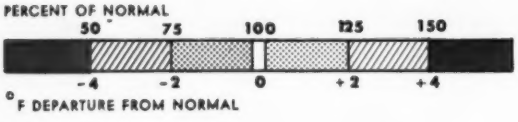
KRICK WEATHER OUTLOOK

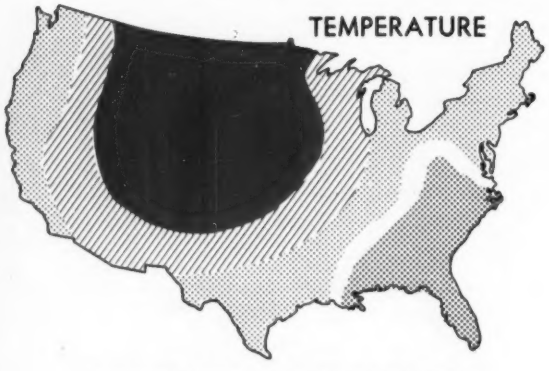
DECEMBER 1959

Prepared Exclusively for CONSULTING ENGINEER

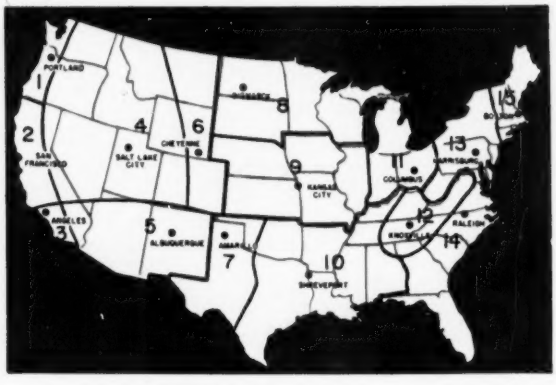


PRECIPITATION





TEMPERATURE



CONSTRUCTION DAY FORECAST LOCATIONS

CONSTRUCTION DAY CRITERIA

To be considered a construction day on these charts, the day's maximum temperature must be more than 38 degrees. There must be less than six inches of snow on the ground. There must be less than six hours of active precipitation during the period between the hours of 7 a.m. and 5 p.m. There also cannot have been more than one inch of rainfall on the preceding day.

DECEMBER HIGHLIGHTS

During December 1959, near seasonal construction weather is expected over much of the United States. The exceptions are the New England, Atlantic seaboard, and southeastern areas, where slightly cooler and quite wet conditions should prevail. The New England area and the lower Mississippi Valley region probably will have the nation's poorest construction weather. Frequent storminess is expected to concentrate in these areas bringing the monthly precipitation totals much above normal. Construction also could be hampered somewhat in sectors of Arizona, as frequent shower activity should bring near or above normal moisture over the region. Warm temperatures, however, should moderate this construction day loss. Predominately warmer than normal conditions are expected over the area extending from the West Coast eastward to the Mississippi Valley and the Great Lakes region. The warmest readings as compared to normal are likely over the middle third of the country, but it must be kept in mind that subzero readings are not uncommon during December in many localities. Although slightly cooler than normal temperatures are expected over the Florida peninsula, rainfall totals should range slightly less than usual, resulting in little loss of construction time due to weather. Over-all, this December should be relatively favorable for construction over much of the country. Only those regions in the eastern United States receiving colder than normal temperatures and above normal moisture should have the number of favorable construction days reduced considerably below normal.

TEAR OUT ALONG PERFORATION.

These forecasts are prepared by Irving P. Krick Associates, Inc., the world's oldest and largest weather engineering firm. The forecasts are based on methods developed by this group at California Institute of Technology prior to World War II. After the War, the methods were adapted to high speed electronic computing machines to shorten the time required to solve the complex problems of the atmosphere. Ultra-long range forecasts, up to a year or more in advance, are now available. Information on other Krick weather services is available by writing to the home office of the firm at 460 South Broadway, Denver, Colorado.

CONSTRUCTION DAYS

DECEMBER 1959 ESTIMATES															
LOCATIONS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
HIGHEST	26	30	31	22	31	24	29	11	25	29	22	28	20	31	21
LOWEST	12	21	26	8	21	11	21	2	10	22	5	17	6	13	7
AVERAGE	20	26	29	15	25	18	26	5	17	26	13	22	13	24	15
ESTIMATE	22	29	29	17	26	19	24	4	20	25	12	21	8	24	11

These estimated construction days for key cities in the United States should be interpreted as an average of estimated conditions over the forecast area. To obtain the best results, the forecast number of construction days should be compared with the temperature and precipitation anomaly maps and the timing estimates to determine the probable number of construction days in your locality. The forecast construction days are based on average construction day requirements as defined under "Construction Day Criteria," and should be adjusted for individual operations.

JANUARY AVERAGE AND RANGE*															
LOCATIONS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
HIGHEST	30	30	31	24	31	26	29	16	21	29	16	28	23	29	16
LOWEST	4	20	26	0	16	1	13	0	8	18	1	16	1	18	2
AVERAGE	16	27	28	11	24	16	23	5	16	23	11	22	14	24	10

FEBRUARY AVERAGE AND RANGE*															
LOCATIONS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
HIGHEST	26	27	28	23	29	23	29	10	26	28	22	26	24	28	15
LOWEST	10	22	21	7	21	8	20	0	9	18	5	15	10	19	8
AVERAGE	20	25	25	18	26	14	25	3	17	24	14	22	15	24	11

*Historical Average, Not a Forecast

DECEMBER 1959 TIMING OF SIG

Slightly warmer than normal is the outlook over the northwest during December. Important storminess is expected during the 10th-12th and 16th-19th intervals. However, nighttime low temperature readings should be above historical averages during this midmonth storminess.

The cold snap indicated at around midmonth on the timing bar should drop nighttime lows into the subzero bracket over many northern sections. Eastern Montana can anticipate the heaviest snowfall in the area during the storminess indicated around the 18th or 19th of the month.

No sustained cold spells are in prospect during December. The indicated cold periods are more precisely periods in which fresh Pacific air plus radiational cooling will make minimums drop briefly. Important storminess is expected during the 12th-13th and 17th-19th intervals.

The storminess indicated on the timing bar around the 5th and the 9th of the month applies principally to southern portions of this four-state area. Intermittent stormy weather is likely in the intermountain region during the 13th-16th interval.

Mild is the outlook for the first seven days, although briefly colder than normal readings are likely in northern Minnesota about the 3rd. Several weather fronts should move across the area affecting principally Canadian border regions, but moisture amounts should be light.

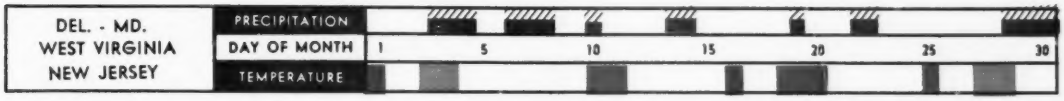
Look for low temperatures in the teens during the cold period indicated just prior to midmonth — subzero readings are likely in many areas around the 22nd or 23rd. Important precipitation is expected during all of the stormy intervals shown on the timing bar.

The first week of December will bring important moisture, though most of the storminess during the month should be brief in nature as frequent weather fronts move across the region. Temperatures during the indicated cold spells are expected to range in the teens.

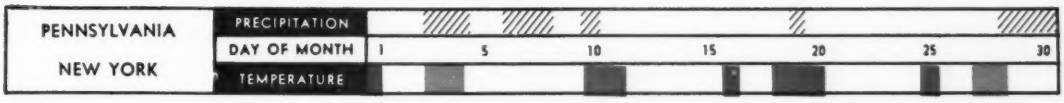
SIGNIFICANT WEATHER EVENTS

RAIN
SNOW
WARM
COLD

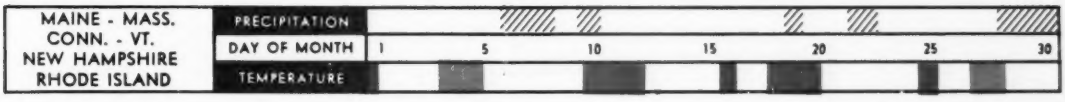
The timing bars below are intended to indicate periods of important general storminess and important departure from temperature normals in areas indicated. They are highly accurate over the area indicated, but are too general to pinpoint small local storminess or showers. Allow one day on either side of indicated storm or extreme temperature periods for general planning. Combination rain or snow shading indicates either one or both.



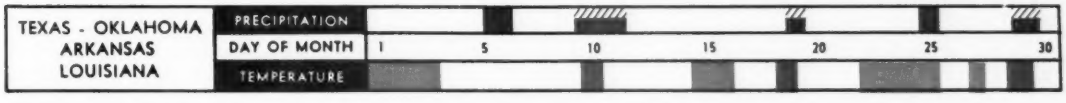
Coastal regions can expect threatening storminess near the 10th and the 13th. The storminess indicated at about the 3rd or 4th should be more important in this region than farther north. Temperatures in the low 20s are likely for the indicated cold periods.



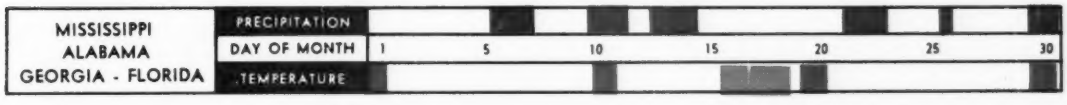
Briefly cold readings are anticipated for the first day or two of December, but a southwesterly flow should bring warmer temperatures by the 3rd or 4th of the month. Look for temperature readings in the 18 to 26 degree class during the indicated cold spells.



Generally much wetter than normal conditions are in prospect over the New England area during December as frequent stormy patterns move across the northeastern extreme of the nation. Briefly cold readings are expected around the 1st, 16th, and 25th of the month.



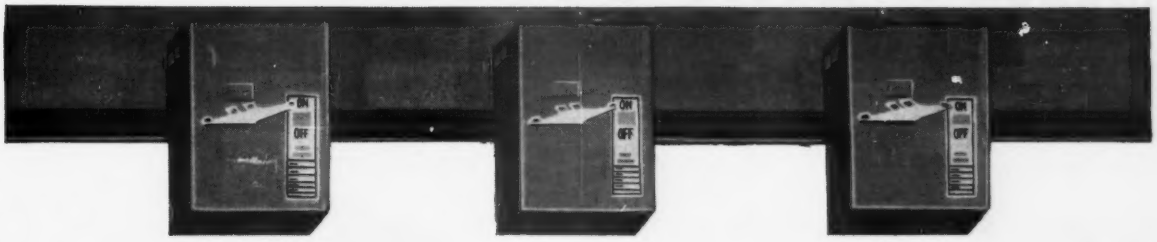
The indicated cold spells are not likely to be unusually cold for December, rather they are the coldest periods expected for the month. Important storminess is anticipated during the 5th-6th, 9th-11th, 18th-19th, and 29th-30th intervals.



Above normal precipitation is expected over much of the Lower South during December, but in Florida the amounts should range from near to below normal. Stormy weather is likely on the Peninsula during all of the periods indicated up to the 23rd of the month.

The 3rd-4th and 13th-14th intervals should bring important storminess. Aside from the showery weather indicated around the 23rd or 24th, the last third of the month should be relatively fair. Cold weather is expected near the 10th-11th, 18th-20th, and 30th-31st.

NEW IDEA!



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Maintenance Hangar for American Airlines located on the Detroit Metropolitan Airport. Mahon Metal Curtain Walls in blue porcelain finish were employed, in this instance, with natural brick to produce an attractive exterior. Wall Plates of the same material painted gray were employed to face the large hangar doors.

Architects & Engineers:
Giffels & Rossetti

General Contractor:
A. J. Etkin Construction Co.

Serving the Construction Industry Through Fabrication of Structural Steel, Steel Plate Components, and Building Products

in Bright Metal or Colored Porcelain Produce Clean, Attractive Exteriors!

Mahon Walls can be Erected up to 60 Ft. in Height without a Horizontal Joint . . . Vertical Joints are Invisible

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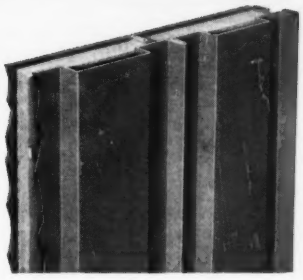
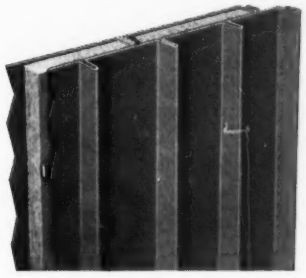
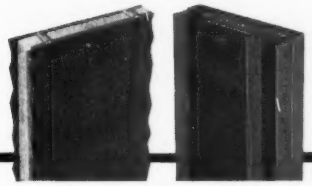


MAHON FLUTED WALL
FIELD CONSTRUCTED



MAHON RIBBED WALL
FIELD CONSTRUCTED



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Field Notes

MARJORIE ODEN,
Eastern Editor

CEC Has Busy Session in Cincinnati

MANY Consulting Engineers Council committee members have been turned into writers, according to reports at the semiannual meeting in Cincinnati last month. Efforts are being made to supply Council members with the basic documents, brochures, and guides of the profession as soon as possible.

The new committee system is being used on the more controversial issues with success. As Joe Williamson Jr., chairman of the ethical practices committee pointed out in his report: "The CEC Executive Committee recently recommended that CEC committees involved with highly controversial subjects be manned by members from one member association. Furthermore, such member association so selected is to understand that all such CEC committee problems are to be recognized as association projects . . . It has been our experience that controversial subjects simply cannot be handled by mail. A five or seven man committee scattered over the 48 states is ineffective, in our opinion."

A number of other rather controversial subjects also have been tackled with notable success, since the New York meeting. The documents committee announced that two standard forms of agreement between architect and engineer have been completed and currently are being reviewed by a firm of attorneys. One was a form of agreement when the fee is a percentage of construction cost — the other a form of agreement when the fee is lump sum. Forms on which the documents committee based the new reports originally were prepared by the New York Association of Consulting Engineers, but the CEC committee explained that the form will be up-dated. An engineer-to-engineer form has been suggested as a future project.

The Surety Association of America also has been working with the documents committee on forms of bid bond, performance bond, and labor and material payment bond. CEC has requested that the Surety Association grant it permission to publish as CEC documents the various bond forms. Details currently are being worked out.

"In general, we believe that the more we adopt or approach standardization as to these and other documents used in construction, the more do we effect economies, sound bidding, and avoidance of disputes and misunderstandings. We congratulate

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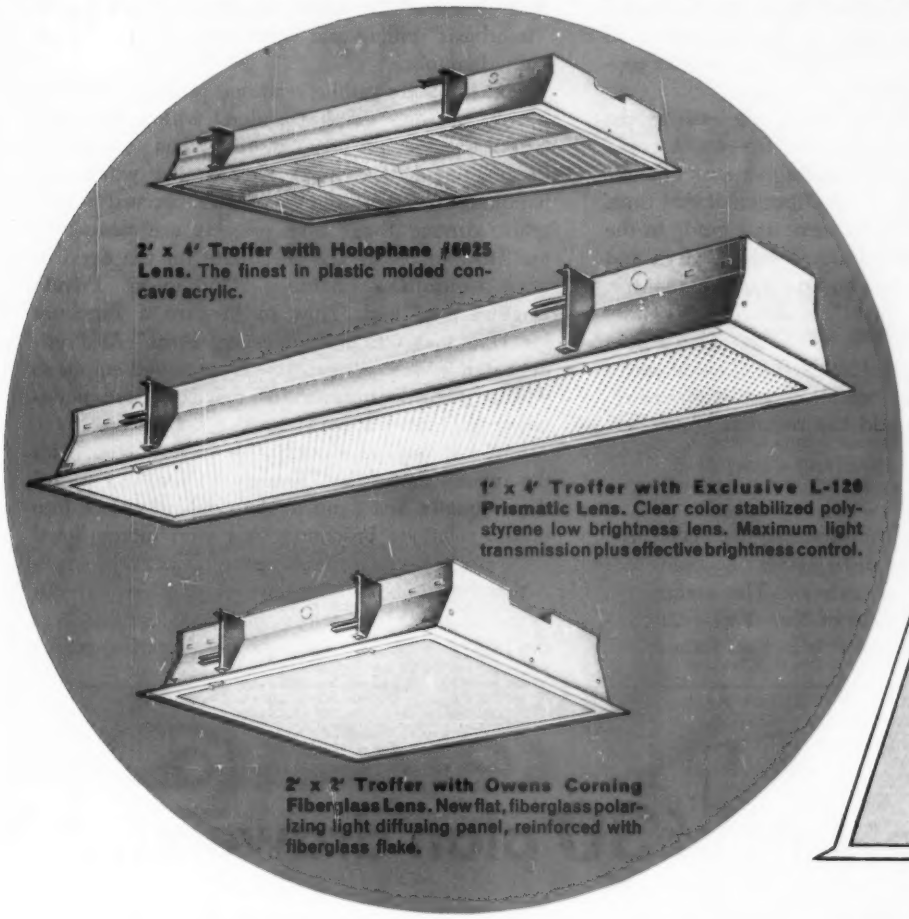
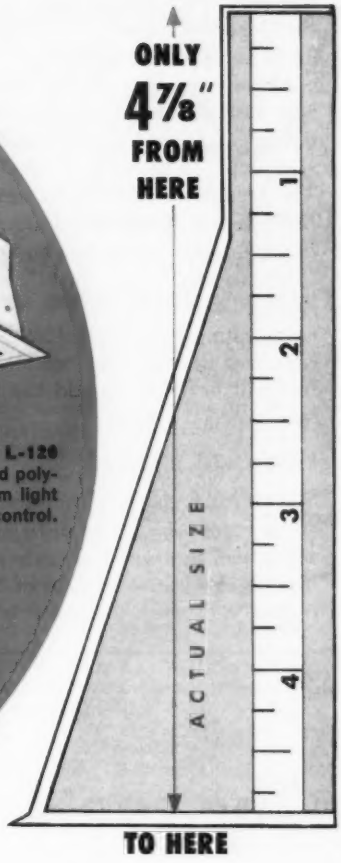
NEW SHALLOW LINE TROFFERS





The newest and finest engineered troffers available today. Laboratory tested and engineered to achieve the latest in modern troffer lighting. *Only* 4⅞" *deep*, these units allow reduced plenum depths and permit greater structural freedom between floors.

New Benjamin shallow-line troffers are the fastest installing troffers on the market. One piece housing in both 4′ and 8′ units gives maximum structural strength. Fused for control equipment protection. The most complete selection of closures in the lighting industry.

For fixture engineering at its finest, look to Benjamin. Your local Benjamin representative will be happy to help you. Contact him on any problem... large or small.

- ✓ **Swivel-bar suspension eliminates overhead yokes, reduces installation cost**
- ✓ **Simplified hinge mechanism ...no screws to tighten**
- ✓ **Positive action tab-lock latch**
- ✓ **Housing fabricated and wired in one piece unit**

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Consulting Engineers Council and its work tending towards such standardization and hope that it will be able to harmonize its product to the fullest extent possible with that of other professional organizations in the field," a Surety official reported.

The documents committee report also suggested that CEC publish a second copyrighted edition of the General Conditions of Contract as soon as copies of the present edition are depleted.

Almost two years work will be completed by the next annual meeting in Portland, Oregon. A copyrighted Manual of Consulting Engineering Practice is expected to be ready for distribution at that time. The Manual is intended to serve as a guide in the performance of consulting engineering services, and as a reference for the fees and contracts committee.

In Cincinnati, the first "Engineering Specialty Listing" was distributed to members. The listing, representing only about half of the Council members, was described as "tentative," and a future effort will be made to add the remaining members to the special roster.

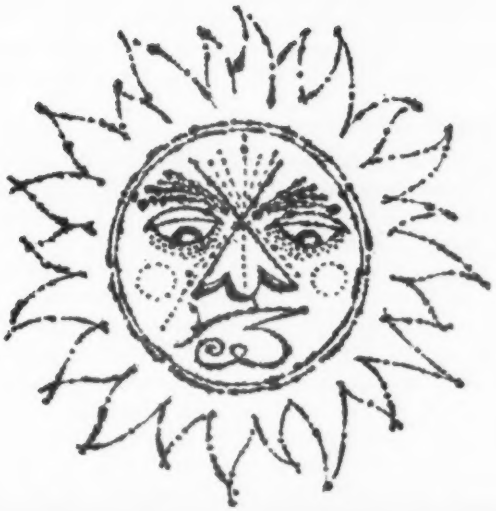
Professional Practices

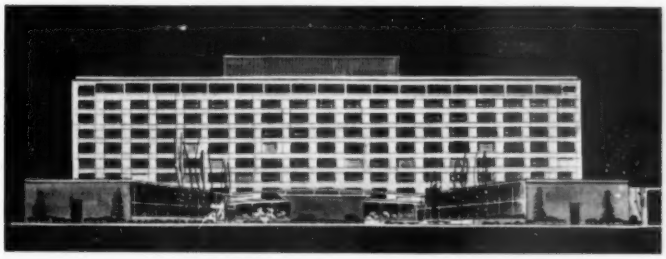
The offices practices committee also has been busy, and a report of expense disbursement accounts was submitted to board members. The committee, headed by Cedric Acheson of New York State, explained that when the report is in final form it will be submitted to a certified public accountant to be sure the recommendations do not run afoul of the Bureau of Internal Revenue.

For future projects, the offices practices group suggests a questionnaire to obtain office expense data, followed by questionnaires on methods of "time basis" billing and accounting procedures for individual jobs.

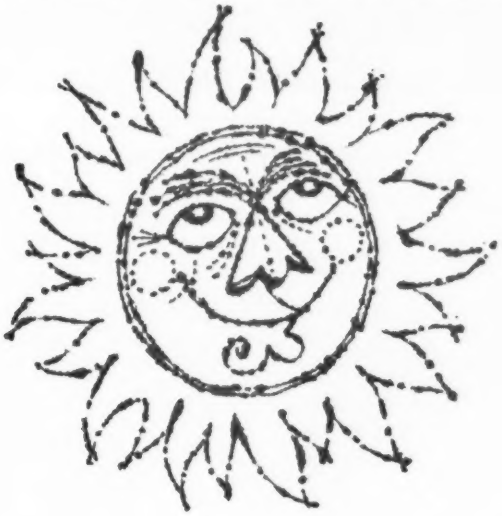
The Council's public relations program also has been given new emphasis, along with a new firm of public relations experts. CEC has transferred its account to the same organization which has handled the Oregon Association's successful program. Among the future projects are pamphlets on "How to Select and Negotiate for the Services of a Consulting Engineer," "Public vs. Private Engineering," and "How to Prepare a Brochure for Your Consulting Engineering Firm." As President Ralph Westcott explained, continued emphasis will be placed on favorable magazine and newspaper publicity for the Council.

Past publications came in for mention too, with the announcement that "Framework for the Future," the Council's first (and to date only) venture into public relations brochures, has won international recognition from Graphis Press of Zurich, the international yearbook publishers of graphic and advertising art. The Council has been notified that the brochure will be circulated to libraries, public





SHERATON-PORTLAND HOTEL, PORTLAND, ORE. Architect: Church, Newberry, Roehr & Schutte; Consulting Engineer: J. Donald Kroeker & Associates; Mechanical Contractor: J. M. Harder Plumbing & Heating Company.



Climate by Chrysler

Pumps out heat in summer, pumps in heat in winter . . . saves money all year for new Sheraton Hotel

The most complete heat pump system ever installed in a hotel is providing a money-saving answer to the problem of all-year air conditioning for the new Sheraton-Portland, in Portland, Oregon.

The system takes advantage of low local power rates and utilizes available well water. In summer, two 250-hp Chrysler Centrifugal Heat Pumps use the water to absorb heat from indoor air and keep the hotel cool. In winter, the cycle is reversed. Heat is extracted from the water and pumped into the hotel.

Individual Chrysler fan-coil units give occupants of each room complete control over indoor climate. Public spaces are served by Chrysler central air-handling units.

The Chrysler Heat Pump is versatile: It also supplies domestic hot water for the hotel's 300 rooms, and delivers, through boosters, near-boiling water for the kitchen. And the system is economical: It costs less to operate than conventional year-round air conditioning . . . and it even warms the swimming pool without added cost.

Whether your air conditioning requirements are best met by a heat pump or conventional air conditioning, Chrysler has the equipment and technical know-how to help you do the job better . . . for less. For information on the mechanics or economics of Chrysler equipment, write today.

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relations firms, ad agencies, and printers throughout much of the world. Westcott termed the award the "Oscar" of the graphic arts profession.

FIDIC and the Council

One weighted vote (the only one of the meeting) was taken to see if, in view of the financial problems involved, the International Federation of Consulting Engineers should be invited to meet in the U.S. during the next 5 years. The answer was "no." The FIDIC invitation was mentioned later, and it was decided to have the sites and arrangements committee investigate the advisability of asking FIDIC to meet in the States sometime in the future.

Gail Hathaway, consultant to the International Bank for Reconstruction and Development (World Bank), also discussed FIDIC during a portion of his banquet speech. Hathaway told of recent correspondence with the British Association of Consulting Engineers complaining about the custom in some parts of the world of asking for bids from which to select a consultant. In the specific instance mentioned, eight American firms submitted bids and three refused to do so.

"It would appear that FIDIC is the most appropriate organization to handle such problems and, inasmuch as eight consulting engineering firms from the United States were involved, it would be most appropriate for a committee on international relations of your Council to give prompt consideration to the proposal of the British Association of Consulting Engineers," Hathaway suggested.

Westcott when asked his attitude toward FIDIC stated, "We will not take the position, as one of FIDIC's newest members, of attempting to tell the international organization what to do. But perhaps we can inspire them in some areas by example."

Fair Labor Standards Act

The executive committee is scheduled to review a directive, from the New York State Association of Consulting Engineers, asking that something be done to clarify the legal haze surrounding the Fair Labor Standards Act of 1938, Wage and Hour provisions, as applied to consulting engineers.

The New York State members pointed out that . . . "the nature of consulting engineering is such that it is not feasible for either principals or employees to always work a regular 40-hour week due to the necessity of providing inspection of construction during whatever hours contractors choose to work; performing surveying services when the weather permits; performing such tasks as flow gaging, sampling, and the examination of troublesome field or process conditions when the weather or the client's processes create certain

critical conditions; and meeting the requirements of clients in regard to the completion of services by specified dates.

"The profession of engineering has successfully supported the clarification of the position of professional engineers in private practice, public life, and industry in relation to the Taft Hartley Act and other labor relations acts through amending legislation and/or interpretations, rulings, or decisions," and New York State suggests that the Council see what it can do in regards to wages and hours. They want to know when time-and-a-half is required, and for exactly which employees.

The matter was referred to the executive committee, and it was suggested that this might be a subject for future referral to the Engineers Joint Council-American Institute of Architects committee.

Problems in Ethics

A new statement on free engineering was adopted, to be published in the Manual of Practice. It was accepted (as originally prepared and adopted by the Missouri Association) with the understanding that the wording might be edited slightly, but the intent of the policy statement retained:

"Free engineering as it refers to the construction industry is the practice of concealing charges for providing professional engineering services in connection with furnishing materials, equipment, or labor of construction. The Missouri Association of Consulting Engineers considers such practice unethical and inconsistent with professional conduct.

"Charges for professional engineering services should be fully and separately proposed, quoted, and invoiced by persons or firms who furnish the services. It is unethical and unprofessional to conceal, lump together, or absorb any part or all of the cost of professional engineering services in the cost of equipment, materials, construction, or nonprofessional services.

"Locally recognized recommended minimum fee schedules establish the principles and minimum charges for . . . professional engineering services."

Another proposed policy statement did not fare so well, and was referred back to committee. It was:

"Whenever a 'standardized' plant, requiring only one basic design, offered by one manufacturer represents a major portion of a project, any resulting saving in planning costs (as compared with costs usually incurred in conventional designs, — completely engineered, drawn, and presented by the Consultant) shall be extended to the Owner by the Consulting Engineer utilizing such a 'standardized' design."

An interesting hearing, to be held soon by the employment practices committee of the Missouri Society of Professional Engineers, also was discussed. On a single project, consulting engineers gave quotations of $9000, $7000, $1500, $200, and $150 to do the same design job. Each of the engineers is to be asked publicly to defend his fee.

Concern Over Legislation

Legislation also came in for its share of attention, with emphasis on the numerous references in various Congressional committee reports to "exhorbitant fees" of consulting engineers.

Lyle Jones, the new CEC Washington representative, told of a visit with George H. Staples of the Comptroller General's staff. The Comptroller General recently issued a report criticizing the use of consultants on Federal and state highway work.

Staples was reported to have explained that it was not his intent to criticize consulting engineers, but instead to criticize the cost-plus type contracts. He also reported favoring state highway departments staffed to handle normal work loads, but leaving peak projects to consultants. "He does not think private consulting engineers can do the job as economically as government engineering departments," Jones added.

The Council is attempting to gather facts with which such ideas of exaggerated consulting engineer fees can be disputed, as well as documented figures on the cost of public engineering. Westcott

Edwards works with consulting engineers

For schools, hospitals, commercial buildings and industrial plants, it makes good sense to specify Edwards products for control, communication and protection.

EDWARDS is the only company that manufactures a complete line of signaling systems.

EDWARDS technical representatives in 58 cities are always available to work with you on application systems.

EDWARDS products are readily available through leading electrical distributors throughout the country.

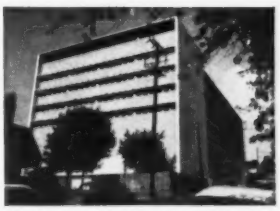
EDWARDS products are preferred 4 to 1 by electrical contractors for simplicity and quality that means quicker installations, no call-backs.

Join with the "Edwards team"; you'll find them most helpful in working with you on any type of signaling problem. We'll be glad to send you the name of your nearest Edwards representative. Technical literature is available on any of our systems or products. Write Edwards Company, Inc., Norwalk, Conn. (In Canada: Edwards of Canada, Ltd, Owen Sound, Ontario)

on all types of signaling installations

Consulting Engineer McCallum goes over plans for University of Tennessee girls' dormitory with Edwards local distributor, L. H. Edenfield of Stokes Electric Company, Knoxville.

Chester E. McCallum, prominent Consulting Engineer associated with Barber and McMurray, Architects, in Knoxville, Tenn., likes to work with the "Edwards team".



Fort Sanders private hospital; Barber and McMurray, Architects: equipped with Edwards signaling systems for communication and protection.

Maryville College, womens' dormitory: Consulting Engineer Chester McCallum tries out Edwards room call system. Compact control panel is shown on wall.

Asbury Acres, Holston Methodist home for the retired, will have an Edwards automatic fire detection system (AMVAD). Control panel is being checked by McCallum (at right).

McCallum discusses plans with Mrs. Ruth Faiclinier, house mother, on site of new women's dorm for 600 girls at University of Tennessee. An Edwards fire alarm system, room call system, and after hours' intruder alarm are only part of Edwards equipment to be installed.

EDWARDS specialists in signaling since 1872

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requested that as many of the CEC members as possible send the Council data on:

¶ All of the elements that comprise the fee of a consulting engineer

¶ Basis for comparing quality and productivity of government personnel and private engineers

¶ Specific instances comparing the quality and resulting construction costs of similar projects or components done by government agencies and by consulting engineers, or providing the cost of typical projects designed by government personnel.

¶ Give the reasons, supported by facts when possible, as to why more economical and efficient engineering can be done by engineers in private practice than by government personnel.

Jones also has visited with a general of the Corps of Engineers, who assured the CEC representative the Corps is happy with the status quo. (The Corps recently was criticized by the House Appropriations Committee for use of consulting engineers.) The general also expressed the opinion that consultants should be used for peak loads, but that the Corps should continue to handle its normal work load.

Council members were warned by Jones to beware of a proposed Bureau of Internal Revenue regulation, which would tax some lobby groups. The regulation would apply to organizations "substantially" engaging in lobby activities. But "substantially" and "lobby activities" are not defined. The result could be a tax on that portion of dues used for anything which could be construed as attempting to influence the opinion of Federal, state, or municipal governments.

Council Finances

President Westcott mentioned that the Council would be about broke if California had not paid its 1959 dues and public relations assessment, and this was confirmed by the budget report. The only associations (on Oct. 31) that had paid in full are California, Missouri, Oregon, and Pittsburgh.

Dues came up for discussion again. Three proposals are to be studied by the directors, questionnaires are to be completed, and dues will receive further scrutiny at the annual meeting. So far, the dues committee reports agreement that:

¶ Regardless of the particular membership structure in any member association, the firm and not the individual should be the criteria for member dues to CEC.

¶ Dues should not be directly proportional to the number of employees and principals, but should be on a declining scale with the number of employees.

¶ Any change that is made should be considered carefully, should be simple and workable, acceptable to all Member Associations, and of a lasting nature.

The three proposed plans use the following bases: the number of principal and nonprincipal professionals, social security plus a fixed sum, or social security with no added sum.

Other Action at Cincinnati

New Members – Pennsylvania, Kentucky, and Indiana joined the Council. Quite a few groups are considered good future prospects for membership.

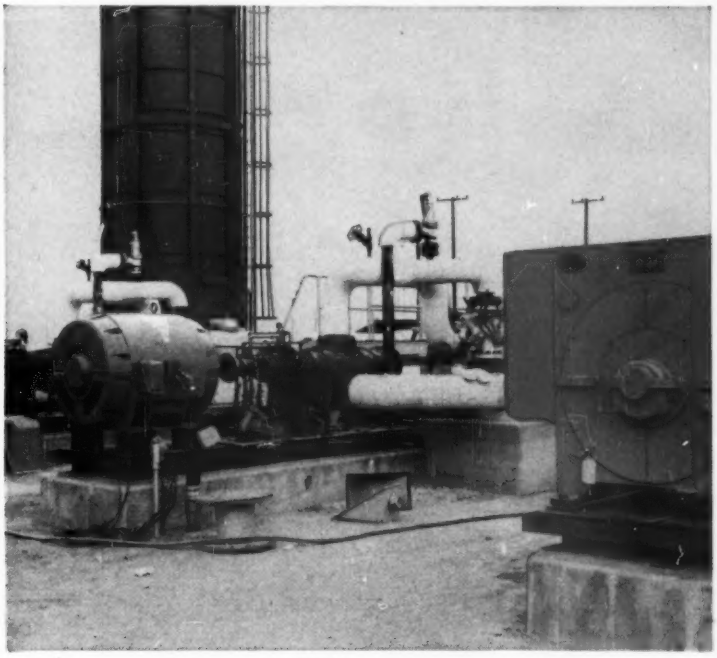
Members-at-Large – It was suggested that members-at-large, who have an association they could join, be assessed the same total dues they would pay for association plus Council dues. Then a portion of the additional dues (based on what the members-at-large would have paid as local dues) would be refunded to the local association. This idea was defeated.

Bylaws – The bylaws are being revised, with a letter ballot to be taken prior to the next annual meeting, in order to have Council membership on an individual rather than an association basis. One purpose of the bylaw revision is to make the bylaws match the more recent articles of incorporation.

Medical Insurance – After investigation, it was decided the rate advantages of handling a group medical insurance policy on a national versus a state level would not be enough to compensate for the administrative detail involved. ▲▲

SILICONE NEWS from Dow Corning

Banish Costly Enclosures



Save on Outdoor Motors by Specifying Silicone Insulation

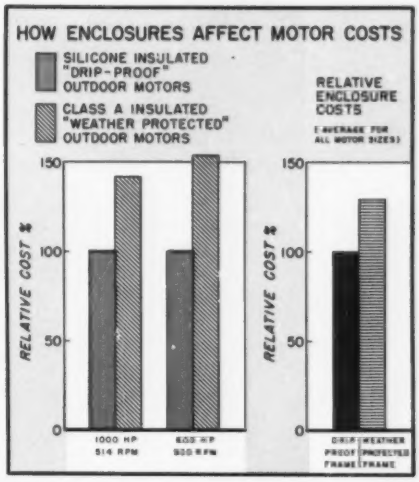
Dramatic proof of size and weight savings made possible by motors with silicone insulation systems is demonstrated by these outdoor direct coupled pump drives at the Alamitos Steam Station of Southern California Edison Company. Here, self-protecting silicone rubber insulation means substantial dollar savings in enclosure cost for the smaller, open frame motor.

Both motors have 400-hp ratings. The difference in weight between the two motors is well over 1,000 pounds. Why is one motor so much larger than the other? Because the smaller Allis-Chalmers motor has a self-protected Silco-Flex insulation system incorporating Silastic®, the Dow Corning silicone rubber. The other motor is insulated with conventional materials requiring the protection of a more elaborate enclosure.

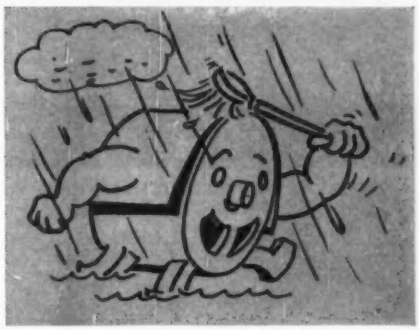
Despite its much smaller size, the silicone insulated motor also has a 15% service factor not found in the larger unit. This extra cushion against overloads assures greater reliability and longer life for the smaller unit.

Silicone rubber insulated motors for pump drives, fan drives, or other applications can withstand torrential rains, corrosive fumes, fly ash, dust, salt air, snow, sleet, cold, heat . . . even flooding! That's why it's wise to specify motors with insulation systems made from Dow Corning Silicones for greater reliability and maximum savings.

For more information, write Dept. 1024.



Savings of 30% and better result from specifying motors with insulation systems made from Silastic. Silicone rubber produces a homogeneous, resilient insulation system unaffected by heat, cold, moisture, abrasives, many chemicals and corrosive atmospheres. No need to buy expensive enclosures. Insulation systems made of Silastic are self-protecting, permit open enclosures outdoors where weather-protected frames would otherwise be required. There's no need for a premium priced enclosure to protect the insulation.



What's more, Silastic's extra thermal capacity provides motors, transformers, and other equipment with additional service factor for absorbing overloads. These motors — with a generous service factor *built-in* — add immeasurably to reliable service . . . operate more economically.

SPECIFY Dow Corning Silicones and **SAVE!**

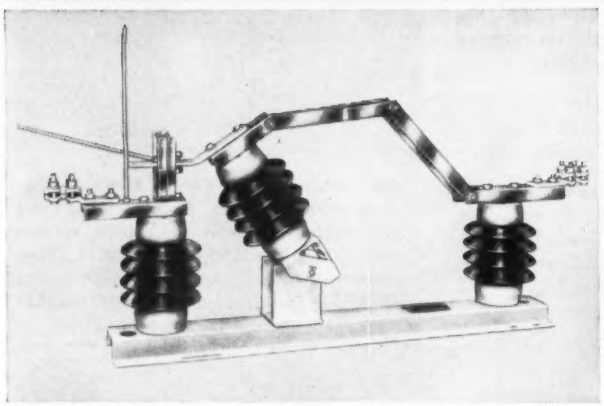
first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

I-T-E Model ETI circuit breakers . . .
specially designed for motor control centers

BETTER-QUALITY EQUIPMENT COSTS NO MORE...



Shuntless tilting insulator switches. Note the absence of corrosion-prone flexible braid on I-T-E tilting insulator switches. Instead they use a durable current-carrying linkage with silver-to-copper contacts at each hinge point. Silver to copper is also employed between the blade and jaw contacts. Switch voltage ratings from 7.5 through 34.5 kv.

Most advanced 600 v power switchgear . . . with new I-T-E K-LINE circuit breakers. Pulldown handle and stored energy mechanism give 5-cycle closure every time. Means longer contact life, greater operator safety, and less maintenance. Wide load range trip adjustment saves later modification. Closed door disconnect protects personnel.

Motor circuits need this PINPOINT PROTECTION

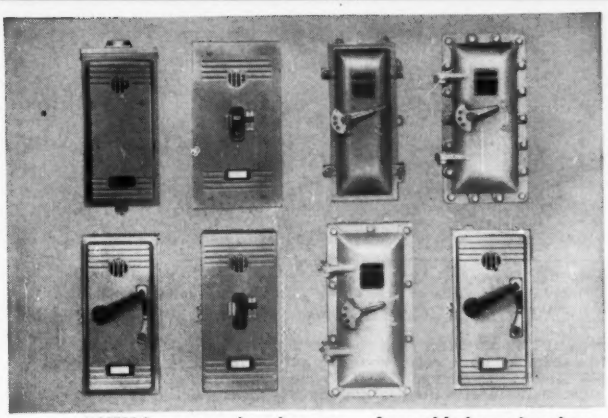
These circuit breakers are special purpose . . . with advantages that motor circuits need for complete protection. Unlike regular circuit breakers, they can be easily set to an instantaneous rating 11 times normal full load current. This gives instant protection against overload damage without nuisance tripping. Regular breakers are preset at instantaneous ratings as high as 100 times full load current.

Look what this difference means. Take the example of a 20 amp breaker recommended for use with a motor starter for a 500 horsepower 440 volt a-c motor. Full load current is 7.5 amp. An ordinary breaker would have an instantaneous trip setting of 500 amp—many times the desired value. A high resistance fault or short circuit current less than 500 amp could do permanent damage before thermal devices would trip the breaker. But a 25 amp Model ETI breaker in this application would have an instantaneous trip setting of only 87 amp . . . giving instant opening in case of high current faults without nuisance tripping.

Model ETI circuit breakers are available in five frame sizes and in ratings up to 800 amp continuous.

I-T-E CIRCUIT BREAKER COMPANY

CHOOSE FROM THE BROAD I-T-E LINE



8 NEMA approved enclosures . . . for molded case breakers. Covering all needs, indoor and outdoor, including dusty and wet environments. Slamproof doors prevent breaker damage regardless of handle position. Pin-type hinges ease installation and service. Doors as well as operating handles may be padlocked for greater safety.

I-T-E Circuit Breaker Company P-4
1900 Hamilton St., Philadelphia 30, Pa.

- ☐ Molded case circuit breakers for motor control centers
- ☐ Tilting insulator switches
- ☐ K-LINE LV Switchgear (600 v)
- ☐ Enclosed molded case circuit breakers
- ☐ Secondary unit substations
- ☐ Metal-clad switchgear (4.16 and 13.8 kv)
- ☐ Power switching centers
- ☐ TRANFO-UNITS*
- ☐ Other_____

**Tranfo-Unit is a Reg. TM of I-T-E*

Name_____ Title_____

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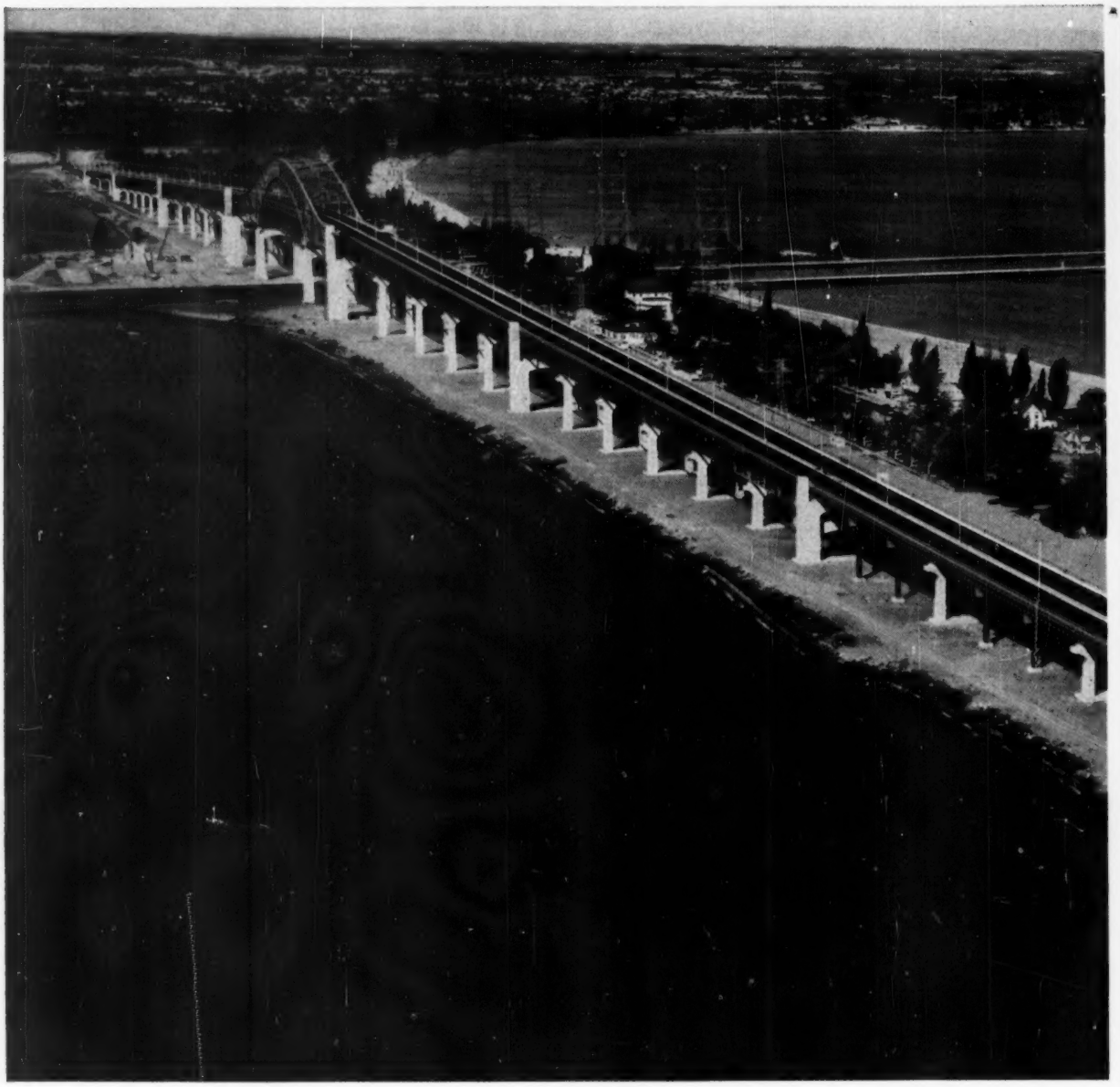
SEND COUPON OR WRITE

Get complete, up-to-date information on I-T-E equipment

USS MAN-TEN High-Strength Steel saves 600 tons

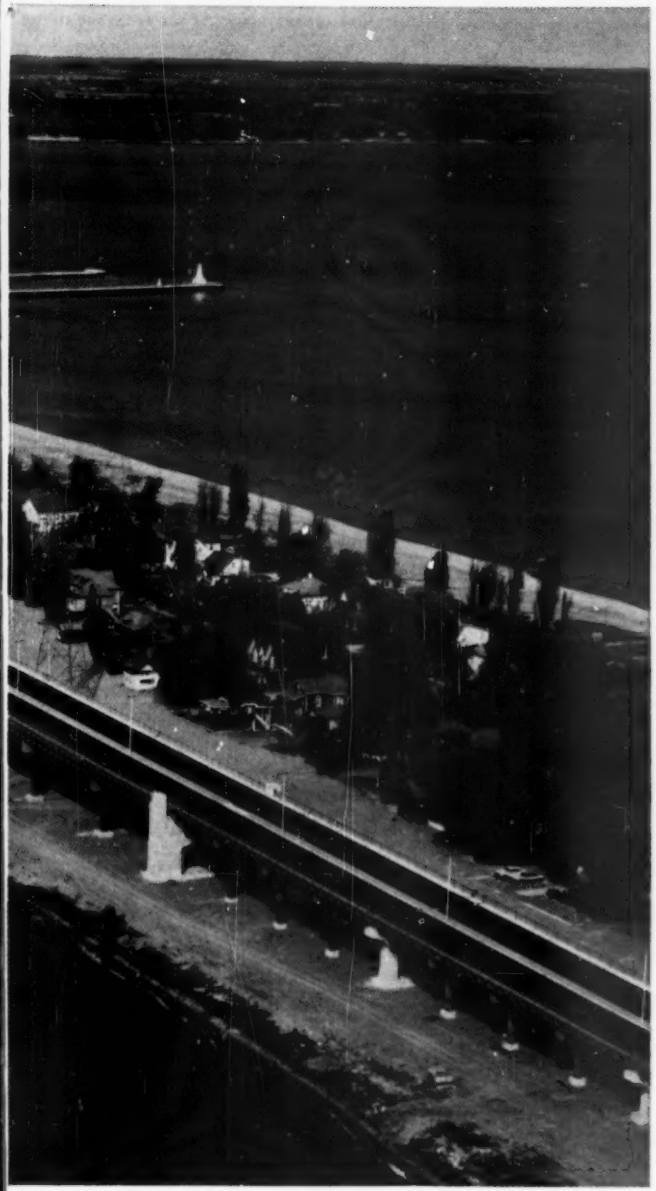


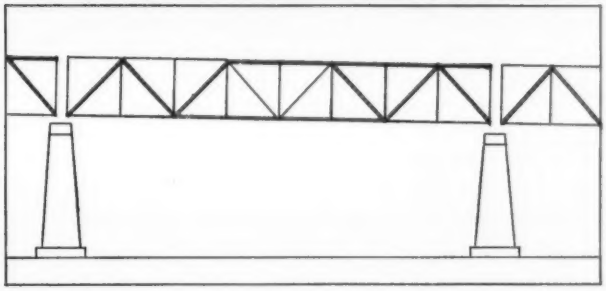
Burlington Bay Skyway. Owner: Ontario Department of Highways. Designer: Foundation of Canada Engineering Corporation Limited. 22-span fabricator and erector: Runnymede Steel Construction Limited.

3,000 tons of USS MAN-TEN High-Strength Steel were used in 22 deck-truss type spans to reduce weight and costs of the Burlington Bay Skyway. MAN-TEN Steel is shown in color in the typical deck-truss span drawing at the right. Because each truss for the 250-foot spans weighed 110 tons rather than 130 tons, it was possible to erect a complete truss in one piece with only two cranes. This materially reduced erection costs.

New color movie available—"Challenge at Carquinez." A 27-minute, 16mm. color film showing the design and construction of the unique Carquinez Straits Bridge. Ideal for engineering groups. For booking information, write United States Steel, Pittsburgh Film Distributing Center, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

# of dead weight in Canada's longest bridge structure





Canada's new Burlington Bay Skyway breaks a serious traffic bottleneck between the city of Hamilton and the town of Burlington at the west end of Lake Ontario. The entire roadway, totalling 8,400 feet in length, is really an elevated four-lane highway with 75 distinct spans. At its peak in the massive central section, the skyway towers 210 feet in the air. It accommodates 50,000 cars per day . . . cost $13.5 million.

How High-Strength steel saved weight and money. All 75 spans were first designed to use carbon steel. Then, in order to reduce costs, cut weight, and still retain the needed strength, 22 deck-truss type spans were modified to take advantage of the higher strength of USS MAN-TEN Brand Steel. MAN-TEN Steel has a minimum yield point of 50,000 psi—50% higher than carbon steel.

98 pounds per foot saved. With USS MAN-TEN Steel it was possible to eliminate a large number of reinforcing plates and extra fabrication costs. A typical MAN-TEN Steel section weighed only 426 pounds per foot compared to 524 pounds per foot for carbon steel. This added up to a total saving of 600 tons of steel in the 22 spans. In this type of structure, each pound saved on the superstructure permits a saving of three pounds in the substructure—a total of four pounds at the footing.

Fabrication costs reduced. The use of simple rolled sections rather than built-up sections made a sizable reduction in fabrication costs of about $20.00 per ton for the average location. In addition, maintenance costs are expected to be much lower because of the elimination of extra plates and rivets.

For more information about USS Design Steels—MAN-TEN, COR-TEN, TRI-TEN Brands and "T-1" Constructional Alloy Steels, write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS, MAN-TEN, COR-TEN, TRI-TEN, and "T-1" are registered trademarks

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United States Steel

USS

Atoms in Action

JOHN F. LEE
Broughton Professor and Head
Department of Mechanical Engineering
North Carolina State College

Soviet Engineering

ONE DOES NOT HAVE TO VISIT the Soviet Union to recognize the fact that both Soviet science and engineering have made tremendous strides. Even to the casual observer it is clear that the Soviet Union has caught up with us in many fields and actually may excel in others. The hard accomplishments are there for all to observe. To deny these achievements would be both churlish and fatal. If we are to profit from Soviet experiences, as they have profited from ours, we must carefully examine the good points of their system of education and their practice in science and engineering. This can be done with full knowledge that not all features of their system are desirable or feasible in a democracy.

Engineering Downgraded

The need to buttress our scientific resources was recognized almost simultaneously with the discovery of atomic energy. Since World War II there has been a concerted effort in this country to promote basic scientific education and research. In satisfying this need we have almost unconsciously attributed to pure science an elevated status which has resulted in an almost dangerous disdain for many applied sciences, particularly engineering.

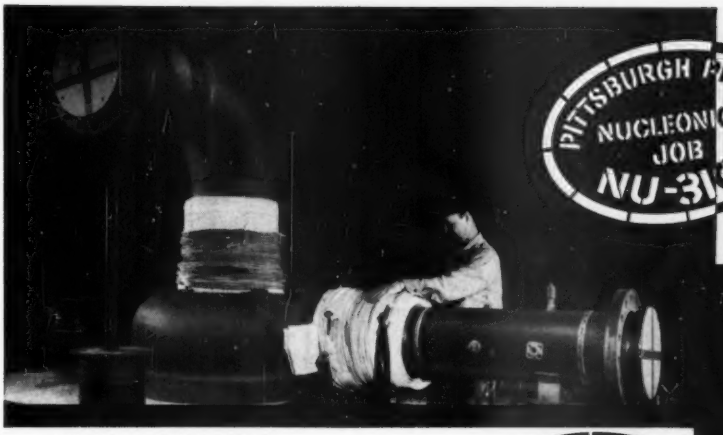
Recent enrollment trends in American engineering schools show conclusively that the increased prestige of science has attracted many students who would otherwise have followed an engineering career. While scientists have quite naturally exploited and enjoyed their new-found prestige, engineers have contributed considerably to the present state of affairs. There has been a hue and cry to set up curricula in "engineering science" or "scientific engineering," with the implication that somehow engineering itself was made of lesser stuff than science. The Soviet Union has not fallen into this trap.

Science is Fundamental

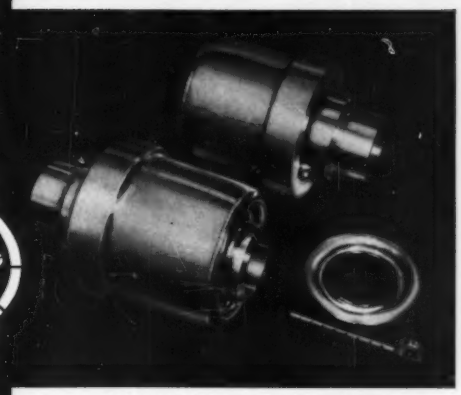
One must accept the fundamental premise that the engineering profession is founded on the discoveries of pure science. With the renaissance of pure science in America, the basis for engineering action became broader and infinitely more complex. Hence the profession of engineering had to seek a more complete and fundamental understanding of science if its practices were not to become rapidly obsolete. This was such a sudden change in the state-of-affairs that some engineers have indeed become hopelessly obsolete. Others have had to change their professional orientation abruptly and drastically. Still others have desperately resisted change. These effects have been felt in every type of engineering practice, both private and corporate.

To satisfy all elements of the profession many engineering colleges have attempted to maintain the old and the new concepts side by side with a prayerful hope that the old concepts could be phased out with time. Meanwhile, there has been an insistent demand for scientists to assume many of the obligations of engineering. In a few instances engineering actually has been written off as entirely too reactionary to respond to change within practical time limits.

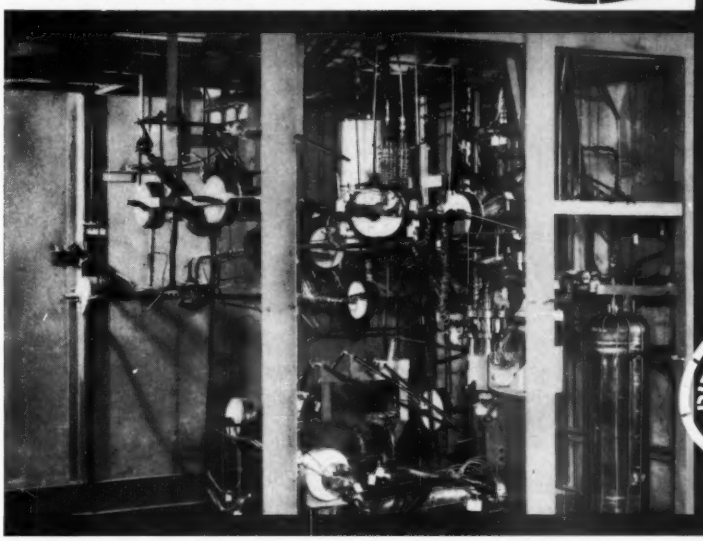
It can be argued that this picture of engineering is overdrawn and perhaps it is. Yet it is undeniable that the public attributes most of our technical advancements (and incidentally, those of the Russians) to science. Engineers who are making in-



VOLUTE ASSEMBLY



BULKHEAD PENETRATOR



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Fabricated by Pittsburgh Piping for Nucleonics

These jobs demonstrate the variety of nucleonic piping work done in our shops. The volute assembly, shown in intermediate stage of manufacture, is fabricated of 14" and 16" Schedule 160 piping materials. The bulkhead penetrator, one of a group, is notable for an unusual method of welding dissimilar metals. The complex test loop requires skillful welding of stainless steel piping materials, and precise assembly of hundreds of components. We are equipped and staffed to do similar jobs for you. Telephone, or write and our representative will call. Or, we will be glad to have you visit our plant.

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PP-40

valuable contributions to modern technology have lost their identity as engineers and are thought of as scientists in the public mind.

Soviet Engineers Move Promptly

The genius of Soviet technical advances rests on important reductions in the time lag between discovery and application of new theories. There seems to be little substantive support for the claim that Soviet science is superior to ours. There is, however, ample evidence that the Soviet Union is surpassing us in a practical sense by getting new discoveries implemented at a rapid pace. In other words, there is considerable support for the contention by some observes that their engineering is often superior to ours.

Our leisurely pace in transferring new discoveries into practical applications has been well demonstrated in the past. For example, the theories of electricity were well developed by scientists for over a century before the efforts of engineers brought them into practice. The physical theory of nuclear fission was well known to scientists for many years before World War II stimulated a herculean engineering effort to bring forth the plants that could produce usable quantities of uranium and plutonium. Penicillin, whose discovery (in 1929) was based on principles developed in 1870, had to wait almost 70 years before engineers designed and built the process plants which made this valuable antibiotic available to mankind. Today there are many wonder metals and other materials denied to our use because the engineering processes for their large-scale and economic production have not yet been designed.

Scientists Not Always Practical

With rare exceptions scientists have never succeeded in translating basic discoveries into human benefits without engineering assistance. And, unfortunately, engineers have not always been credited with their own achievements. To the uninformed, the works of such engineers as Von Neumann, Bush, Von Braun, Steinmetz, Killian, von Karman, and a host of others generally are attributed to science. Even the historical facts of the establishment of such engineering sciences as thermodynamics, heat transfer, fluid mechanics, reaction kinetics, and electronics have in some manner been obscured in the hurly-burly of scientific adultation in this country.

More Implementation Needed

To return now to the weaknesses in our system of science and engineering compared with that of the Russians, we need to recognize some further facts. Since World War II we have spent billions of dol-

The Importance of Balanced Compounding in Portable Cable Design

A portable cable is constantly under attack from many different directions. It is dragged over rough floor surfaces and rocky terrain, crushed under the wheels of trucks and carts, continually bent, flexed and stretched. In addition, it is very often subjected to attack by water, solvents, oil and ozone.

To give long, dependable service, portable cables must be able to withstand rough treatment, and must have built-in protection against all deteriorating factors. Moreover, they must possess other desirable qualities such as lightness and flexibility.

The science in designing these cables is to add the necessary ingredients in the jacket to provide maximum protection along with the maximum of other desirable features. This is where *Balanced Compounding* comes in. It is very easy to provide protection against one or two of the deteriorating factors, simply by loading the compound with an ingredient which is impervious or highly resistant to these factors. Unfortunately, however, the ingredients which provide resistance to abrasion or crushing may be highly susceptible to attack by oil or water; and vice versa.

The cable designer's problem, then, is to attain a balance in his compounding formula which will provide maximum protection against one deteriorating factor without reducing protection against others below the danger point.

To the buyer of cables, this means that *quantity* of any one ingredient is unimportant, unless it is considered in relation to the over-all ability of the cable jacket to resist *all* of the abuses to which it is subjected.

For balanced resistance to all these abuses, the best assurance you can get lies in the quality of the research and development facilities of the manufacturer, and the product's record of performance.

This is one reason why — in those industries where portable cables are continually used or purchased as components of a manufactured product — Simplex Tirex Cables are regarded as the standard.

Proof of the worth of Tirex *Balanced Compounding*, which gives balanced resistance to all the deteriorating factors of normal use, can be found in the fact that Tirex cables have been successfully performing under the most rugged operating conditions for periods ranging up to twenty years.

BALANCED COMPOUNDING CURED IN LEAD

Simplex

WIRE & CABLE COMPANY

Cambridge, Massachusetts and Newington, New Hampshire

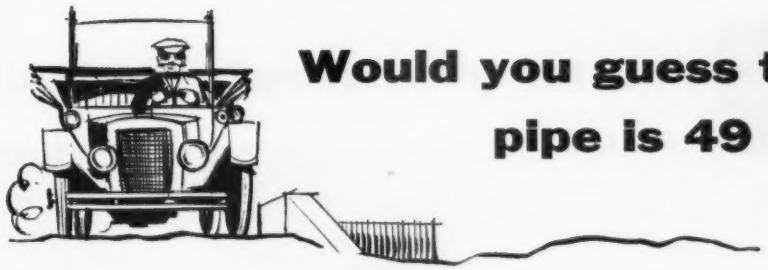
lars on what is called basic scientific research. Fundamentally, this money has been well spent, and we could indeed further increase our financial support of such research.

However, we have been quite niggardly in supporting the development needed to translate the fruits of basic research into practical application. It is estimated that approximately half of the billions of dollars spent on basic research is wasted because the flow of new discoveries into the industrial life of the nation has been entirely too slow. The Russians have not made this mistake. They have accorded equal status to engineering and science in all respects, particularly in regard to research facilities. Hence the flow from basic research to practical application is already moving rapidly in the Soviet Union, and there is every indication that it will continue to accelerate.

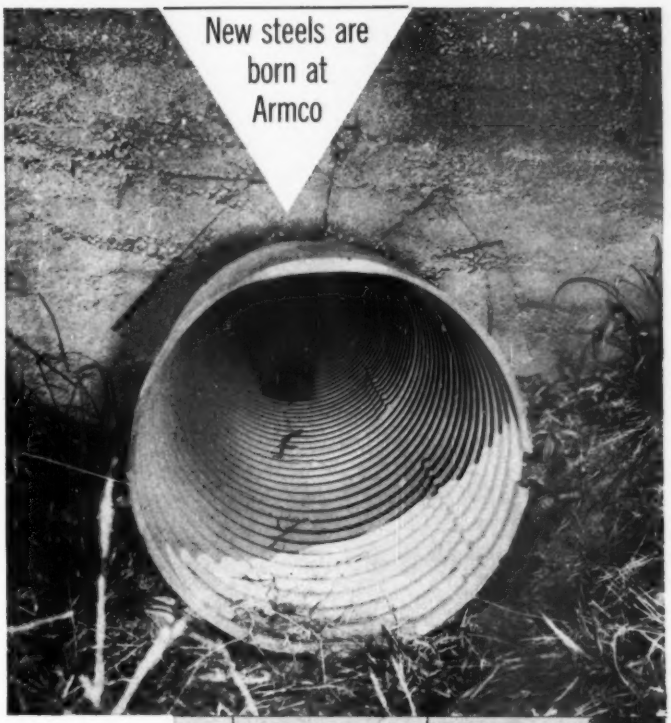
The recognition of the importance of this flow has been so sharp in the Soviet Union that drastic action has been taken. About two years ago Khrushchev ordained that all students of engineering and science must experience service in industry prior to matriculation at the universities. The same edict provides for the return of engineers from industry to the universities every sixth year. In other words, the Soviet Union has taken steps to insure that its future scientists and engineers will have a better perspective of the practical possibilities of scientific discoveries and, at the same time, has protected its industrial complex from the possible obsolescence of its engineers. Moreover, the Soviet Union has taken very special pains to develop the "inventor" type of individual, as opposed to the normally recognized type of researcher, in a variety of special institutes.

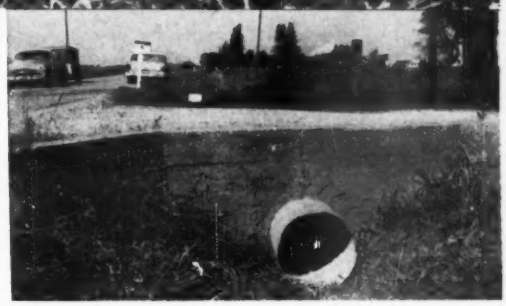
Engineers' Role Clear

Since different techniques for the solution of the problems of education and for the practice of a profession must be used in a democracy, one hardly would suggest that the Khrushchev edicts would be either desirable or practical here. Nevertheless, we must find ways of strengthening the important link between basic science and its applications. The engineer provides this link. The words "engineering science" constitute a redundancy since modern engineering is scientific in approach and in practice. To meet the needs of modern engineering we must foster bold new educational programs for our youth and provide the opportunity for many of our practicing engineers to refresh themselves at the scientific well. We cannot keep pace with Russian progress by producing new engineers educated in an archaic tradition, nor by letting our practicing engineers continue on the road to obsolescence. ▲▲



Would you guess this Armco pipe is 49 years old?





Recent photo of culvert site.

Probably not. But this Galvanized Armco Pipe, 24 inches in diameter and 36 feet long, has been serving as a culvert under a farm entrance road since 1910.

This culvert has been periodically inspected by engineers as a part of Armco's continuing research on the durability of highway conduits. And for the past 30 years the condition of the structure, in both material and structural durability, has been about the same. How much longer do you think it will last—25, 50, 100 years?

For more details on Armco Corrugated Metal Drainage Structures, write us. Armco Drainage & Metal Products, Inc., 7419 Curtis Street, Middletown, Ohio. In Canada: Guelph, Ontario.

This recent photo shows a close-up of a 49-year-old Armco Pipe, installed as a culvert in Darke County, Ohio.

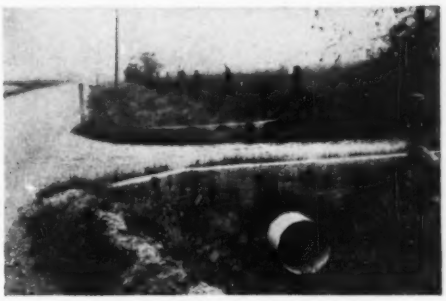


Photo of culvert in 1924.

LITERATURE FOR CONSULTING ENGINEERS: "Brief Data on Armco Corrugated Metal Drainage Structures;" "Sewer Manual;" "How to Install Corrugated Metal Drainage Structures;" and "Armco Products for Industry." In writing, mention literature desired.

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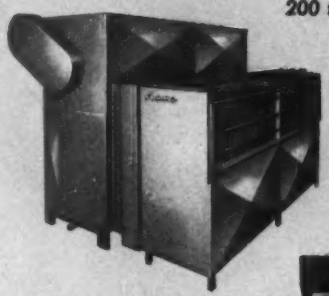
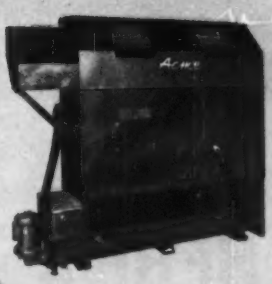
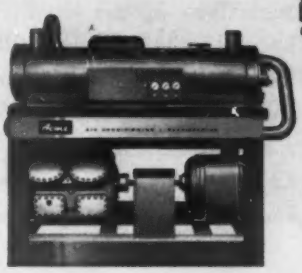
You'll find, too, that Acme equipment . . . available in every case in a wide range of models and sizes . . . gives you system flexibility, smooth, quiet, dependable performance, and long-life ruggedness. You can count on it, because Acme air conditioning and refrigeration equipment has "set the pace" since 1919.

AIR HANDLERS
Central station, multi-zone, remote room conditioners, 200 thru 36,000 CFM.

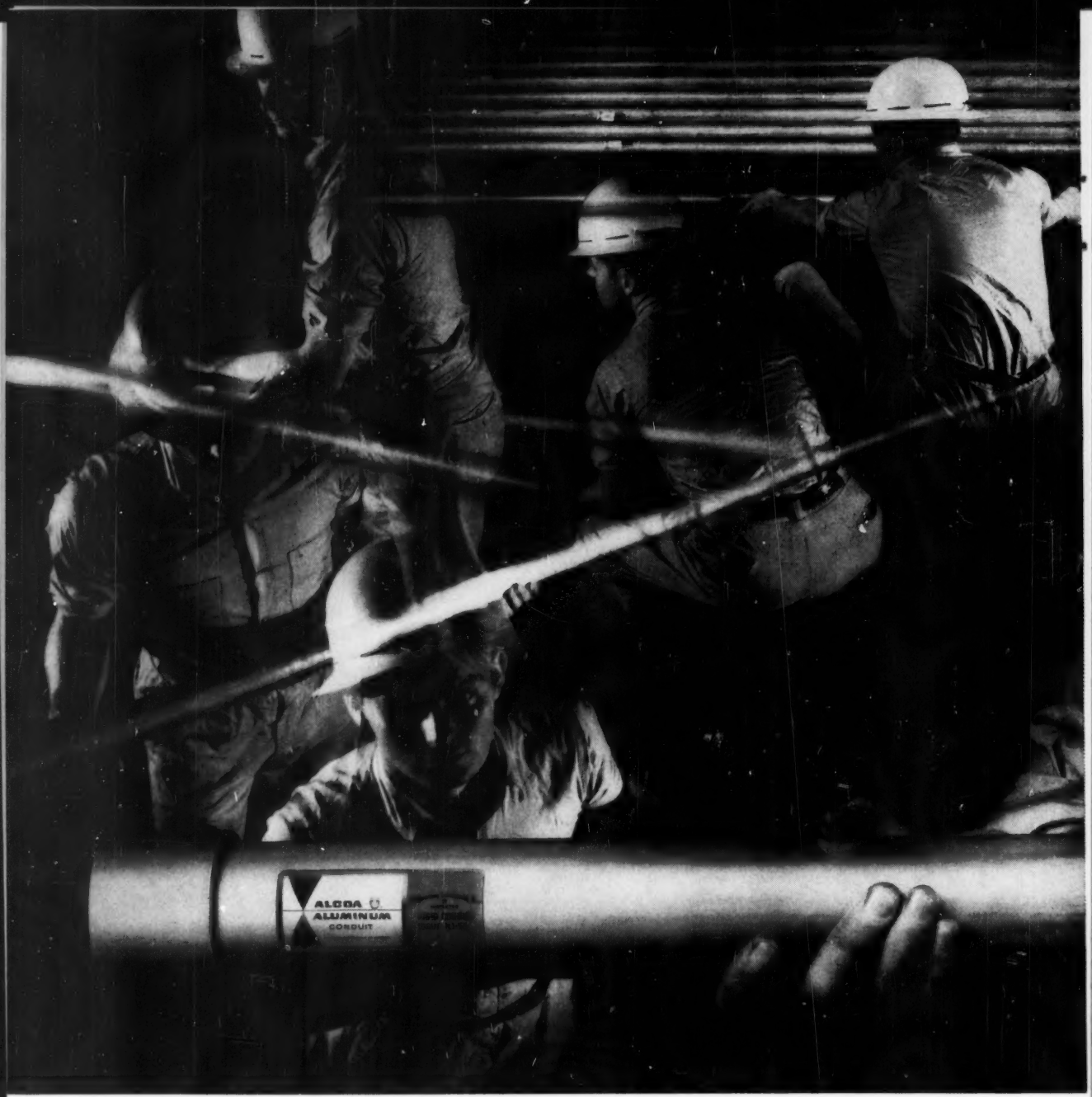


WATER SAVERS
Cooling towers, evaporative and air cooled condensers, 3 thru 120 ton capacities.





PACKAGED CHILLERS
Seven basic models, size ranges for every need from 1¼ thru 125 tons.



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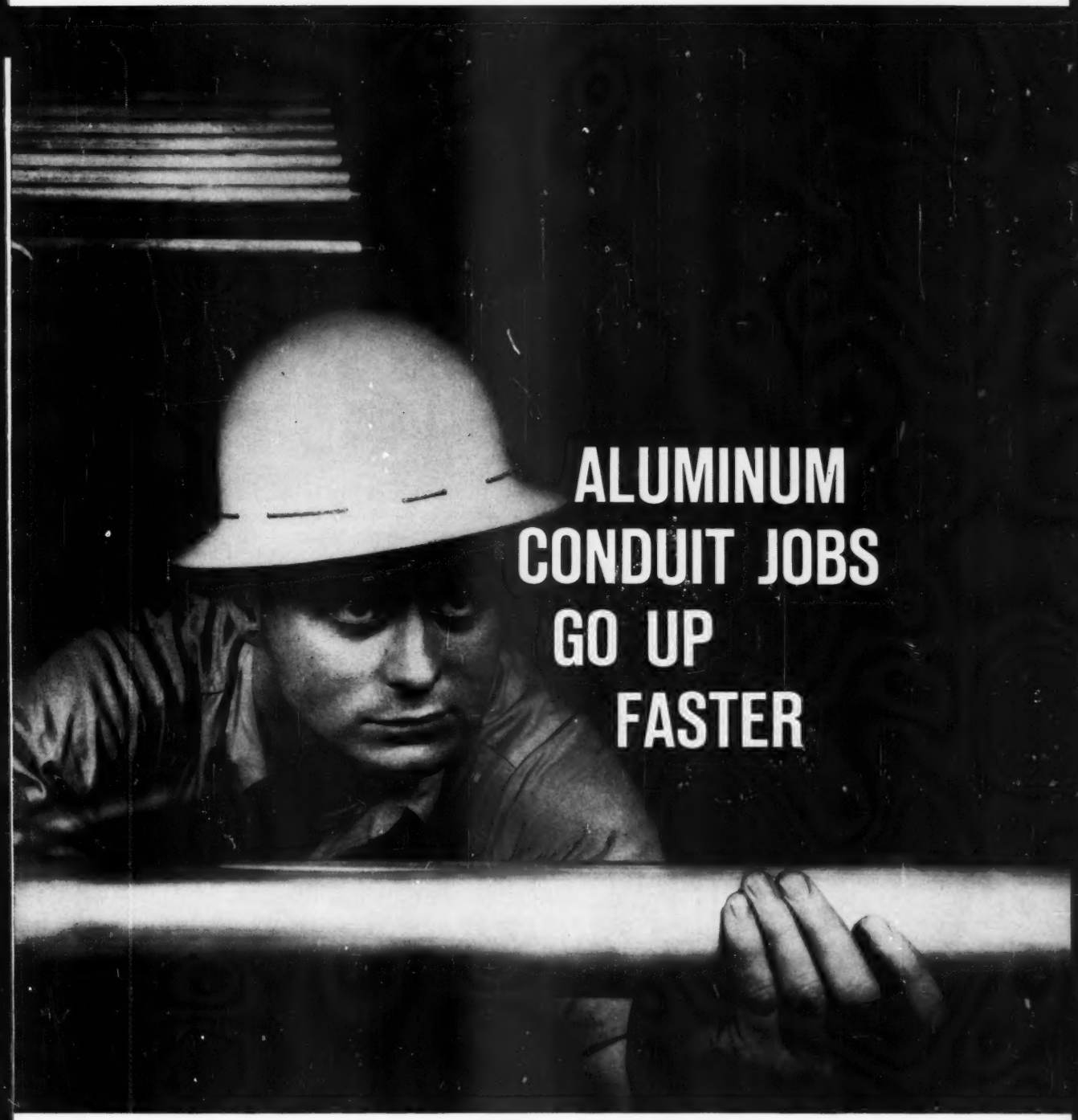
Light weight—weighs only ⅓ as much as steel . . . **easier to handle** regardless of the job . . . **easy to cut, bend and thread,** and without special tools . . . **competitive in price . . . nonsparking** for safer installations . . . no special nonsparking tools required . . . **corrosion resistance** means no maintenance under normal service conditions . . . **color coded** for fast, accurate size identification. **Approved by Underwriters' Laboratories, Inc.** . . . and it's **available from local distributor stocks** for fast, dependable delivery.



Aluminum conduit not only makes jobs go up easier, faster and therefore more profitably, but also helps you give your customers a higher quality, longer lasting installation. Why not use aluminum conduit on your next job? Start enjoying all the many advantages which only timesaving, costsaving aluminum conduit can provide. Your local Alcoa or Rome distributor can give you all the facts and figures for any particular installation. Or, write to Rome Cable Division of Alcoa, 2145-M Alcoa Bldg., Pittsburgh 19, Pa.

ROME CABLE DIVISION OF **ALCOA**

ALCOA ALUMINUM

Your Guide to the Best in Aluminum Value

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The Word From Washington

EDGAR A. POE
Consulting Engineer Correspondent

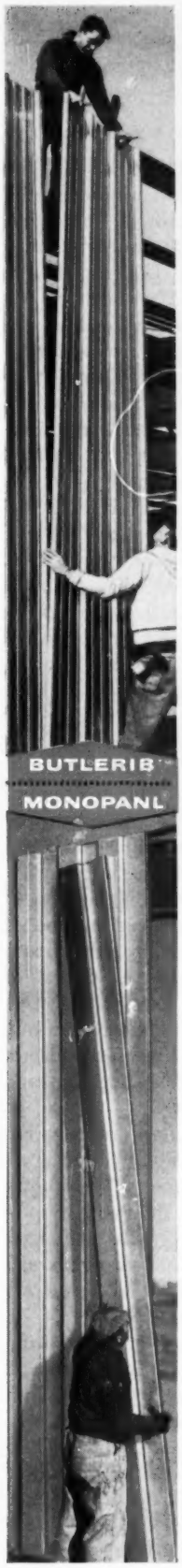
CONGRESS does not suspect any wholesale grafting or racketeering in connection with the mighty highway construction program under way in this country, but it is planning to take a long, searching look into scattered complaints of wrong doing. The Interstate System alone is going to cost some $50 billion or more before it is finished. That is a huge sum of money. Compare this amount with our national debt of nearly $290 billion.

Representative John A. Blatnik, Democrat of Minnesota, chairman of a House Public Works Subcommittee, said the initial hearings on highway spending will not begin until some time after Congress convenes in January. Said he: "Our success for the first three months will depend almost entirely on our investigators. I can't see any committee work during that time unless something urgent is uncovered. There will be some hearings in Washington and some in the field, depending on where the hearings are needed."

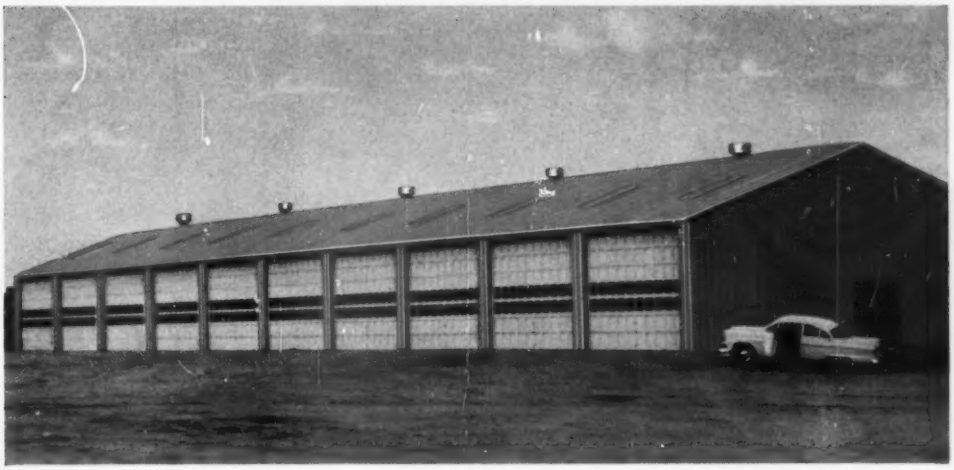
Why was the committee created, and investigators hired? Representative Blatnik said that many complaints were pouring in, and numerous members of Congress started griping when a shortage of funds cropped up and more funds had to be raised to keep the Interstate System going. He added: "There were complaints of overdesigning, overspending, waste, and so on. It then became obvious that Congress should take a good look at all this. That's what this committee is for."

Industry Wary

The general manager of Atomics International, Chauncey Starr, vows that industrial firms are beginning to shy away from the commercial development of atomic energy. Speaking in the Nation's Capital, at the sixth annual Atomic Industrial Forum, Starr said the loss of enthusiasm grows out of the increased availability of conventional fuels, insufficient profit motivation, and the decrease in competition from the Soviet Union and Britain. Starr maintained that the profit motive has been neglected as if it were immoral, and that perhaps the United States will have to wait for a



A BUTLER BUILDING EXCLUSIVE...CHOICE OF TWO SUPERIOR WALL PANELS IN COLOR



Buildings that don't tax your budget

...pre-engineered by Butler

Big or little . . . plain or fancy . . . there's a Butler pre-engineered building to meet the requirements of your community. These examples are typical of the hundreds of buildings throughout the United States that have been built by many progressive, cost-conscious communities. They all have three important advantages: Clear-span interiors that offer maximum use of inside space; load-bearing rigid frame structurals that permit complete freedom in construction and design of outside walls; and mass production economies that result in money-savings for the taxpayers.

Whether you need a "shirtsleeve" building for maintenance use or a "monument" with a handsomely designed exterior, there's a Butler building to fit your needs. And, metal buildings are not all alike! We invite you to compare Butler's two superior new wall systems with all others designed for pre-engineered structures . . . Butlerib, the new improved standard wall and roof panel, and Monopanl, the exclusive, factory-insulated curtain wall. You'll find they're the finest. Or, your Butler Builder will be happy to work with your architect in using a wide variety of curtain wall materials – such as glass, wood and brick.

Why settle for less than the best . . . build with Butler, the lowest cost way to build well. Before you build, call your Butler Builder. He's listed in the Yellow Pages under "Buildings" or "Steel Buildings."

BUTLER MANUFACTURING COMPANY

7512 East 13th Street, Kansas City 26, Missouri

BUTLER®

Manufacturers of Metal Buildings • Equipment for Farming, Oil Transportation, Outdoor Advertising • Contract Manufacturing

Sales offices in Los Angeles and Richmond, Calif. • Houston, Tex. • Birmingham, Ala. • Kansas City, Mo. • Minneapolis, Minn. Chicago, Ill. • Detroit, Mich. • Cleveland, Ohio • Pittsburgh, Pa. • New York City and Syracuse, N.Y. • Boston, Mass. Washington, D.C. • Burlington, Ontario, Canada

surprise announcement by the Russians before the atomic energy stimulus is revived.

More Money for Missiles

Pentagon higher-ups, talking privately, believe that transfer to the Air Force of most of the major space projects will mean more missile money from Congress in the long run. Formerly much of the missile work was handled by the Advanced Research Projects Agency. However, ARPA became the target for much criticism because of the Soviet Union's spectacular missile success, plus what seemed to be a lack of progress in the United States missile field.

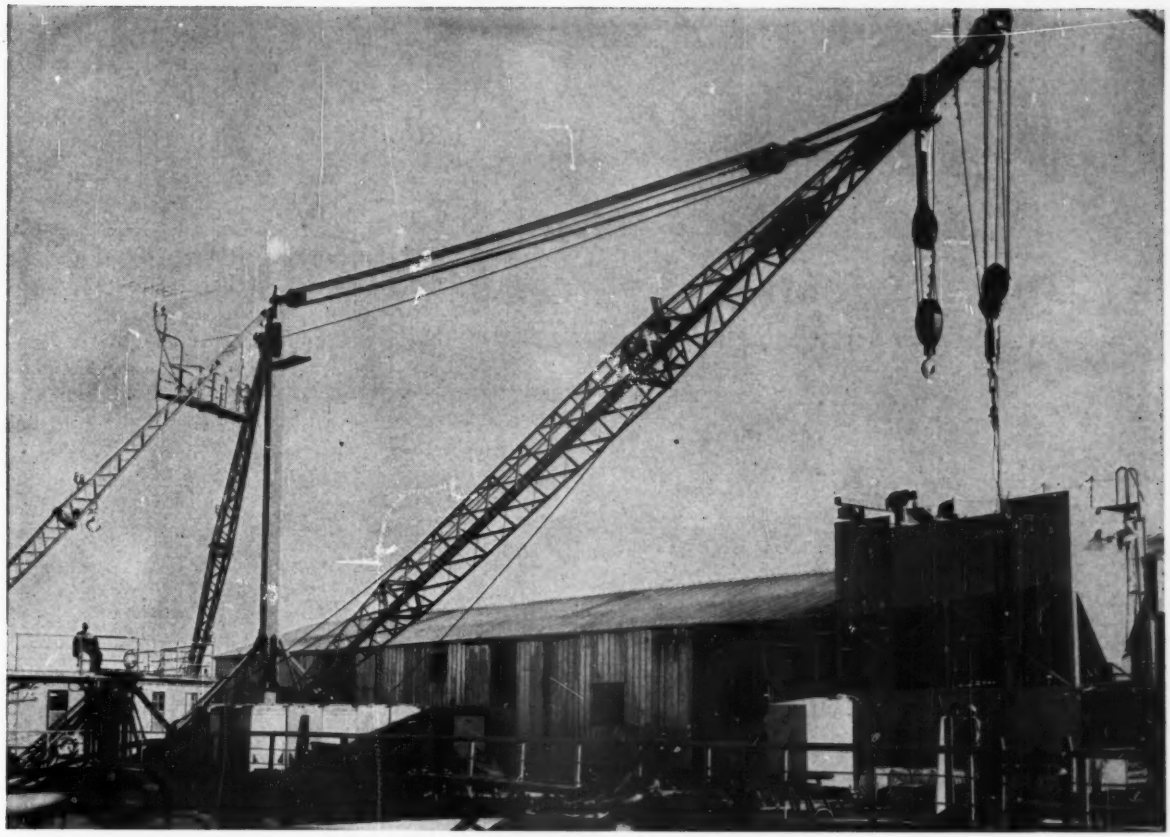
Congress is more likely to vote the necessary billions for space exploitation if the request comes from the Air Force rather than from ARPA. ARPA is not abolished and will continue to perform certain other functions in the missile field.

World Bank Activities

Officials at the World Bank agree that South Africa holds great promise of developing into a substantial market for United States goods and services within the next few years. Nigeria, with a population of 40 million and a national income of $2.75 billion from tin, rubber, and petroleum products, is typical of the possibilities for United States markets. However, more than any single thing, fast growing Nigeria needs immediate engineering and technical know-how.

The Nigerian government has credits in English banks totaling almost $400 million. The country needs a number of plants to produce consumer goods and farm equipment, also power plants and adequate highways to move the necessary raw materials.

The Small Business Administration, after a two-team survey in Nigeria, says a pool of several firms could reap a bountiful harvest from investments in that country. There will be a great need for consulting engineers to help blueprint fac-



For smoother operation on a drilling rig . . .

Clyde Derricks and Hoists pass all tests!

Oil exploration is a costly proposition . . . more so when the operation is off-shore and all materials and supplies have to be hoisted onto the drilling platform. Delays or breakdowns are intolerable. Idle men and machines could pyramid losses into an astronomical figure. Material handling equipment must be dependable, fast, safe . . . operate around the clock with a minimum of maintenance. That's why Clyde Equipment was selected for this ultra-modern rig.

Off-shore drilling rigs need hoists and derricks that have good capacity and are capable of handling materials and supplies at long radius. They must be safe and easy-to-operate . . . require a minimum of deck space. Servicing must be so incidental that it can be easily taken care of on-the-go. Though highly specialized in operation, sea-worthy machinery must be proved beyond doubt. Standardized parts and service must be immediately available if required.

Clyde Derricks with Clyde Hoists were the choice for this Kermac Rig. The owners knew that Clyde Equipment has been performance-tested in hundreds of installations, that savings would be made by using Clydes to meet . . . no, to excel . . . every standard of comparison!

Why don't you look into the improvement Clyde deck and dock material handling equipment can make in your costs and work schedule?

For off-shore, for ship or shore . . .
Consult Clyde's Marine Engineering Department

Closeup of the landing for the tender from which the Clyde Hoist and Derrick quickly and easily handles needed supplies.

CLYDE

A SUBSIDIARY OF RIC — REPUBLIC INDUSTRIAL CORPORATION

CLYDE IRON WORKS, Inc.

Established 1899
DULUTH 1, MINNESOTA

HOISTS : DERRICKS : WHIRLEYS : UNLOADERS
BUILDERS TOWERS : CAR PULLERS : ROLLERS

tories, plants, and transportation systems, once the necessary capital is made available.

Meanwhile, other areas have received attention. Eugene R. Black, president of the World Bank, visited Colombia and Peru in November, in order to acquaint himself personally with the problems of economic development of these Latin American countries.

President Black had conferences with government and private officials pertaining to future projects. In addition, he visited some of the projects which the Bank has financed. Orvis Schmidt and Kenneth R. Iverson, of the Bank's department of operations for the Western Hemisphere, accompanied the peripatetic Black.

Bridge Clearance Increased

The American Association of State Highway Officials is now on record recommending an increase in the minimum vertical clearance for bridges on the Interstate System from 14 feet to 17 feet. Highway officials estimate that the higher minimum bridge clearance standard for structures under construction or to be constructed will increase the program cost by $300 million. The Department of Defense originally requested the change.

Officials estimate that about 8000 bridges have been built or are ununder construction under the 14-ft minimum standard, and some of these will have to be modified to meet defense needs. Secretary of Commerce Frederick H. Muller will make the final decision.

Urban Property Values Drop

There is a growing demand for Congress to undertake, through hearings, a study of decaying central cities across the land. Motor vehicle traffic is choking them to death, and urban property values are dropping in nearly all large cities, including government-rich Washington, D. C.

Meantime, engineering authorities who have been making studies

of congested urban areas agree that unless the people act and install integrated rapid transit systems, "downtown" is going to die.

Pointing out that the average private commuter automobile carries only 1.8 passengers, a spokesman for the Greater Boston Chamber of Commerce warned: "If commuters continue to move farther from the city, and we accommodate them with wider highways, and if we continue to build downtown garages, eventually we will destroy the downtown area, the commuters' places of employment, and the commuter himself."

Private Utilities Expand

Privately-owned electric utilities serving the Fourth Federal Reserve System (Ohio, Pennsylvania, and parts of West Virginia and Kentucky) are planning to increase their present capacity by another 20 percent by 1961. The generating capacity was increased 135 percent from 1948 to 1958.

The Fourth Federal Reserve System said its survey showed that the predicted generating capacity increase will be achieved by building new power stations and expanding existing plants. The largest quantity of new capacity installed in recent years and presently under construction in the District is along the Ohio River.

The Shippingport atomic power plant in Western Pennsylvania has been in operation since 1957, and new nuclear power stations are being constructed by major utilities serving the District. A small nuclear reactor now being built at Piqua, Ohio will supply electric power to that city's municipal power system.

Public Works Bill

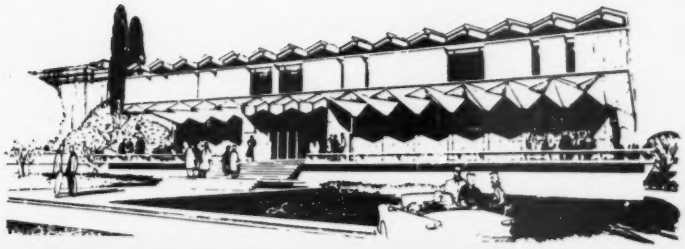
Across the Nation a tremendous amount of engineering work is either getting under way or will be under way early next year as a result of the $1,176,580,000 public works bill passed by Congress over President Eisenhower's veto. The bill, as passed by Congress, includes allocations of $868,204,000 for the civil works program under the supervision of the Army Engineers; $250,368,000 for the Bureau of Reclamation; and $15 million for the Tennessee Valley Authority.

Cloud Height Indicator

A special purpose computer for the Weather Bureau will analyze data received from a cloud height indicator. Known as a ceilometer, the device was developed by the National Bureau of Standards.

This small-scale data processor not only will show what the cloud height is at the moment, but what the highest, lowest, or predominant cloud height was at any time in the last 10 minutes. The device can measure the height of clouds from the ground up to 10,000 feet.

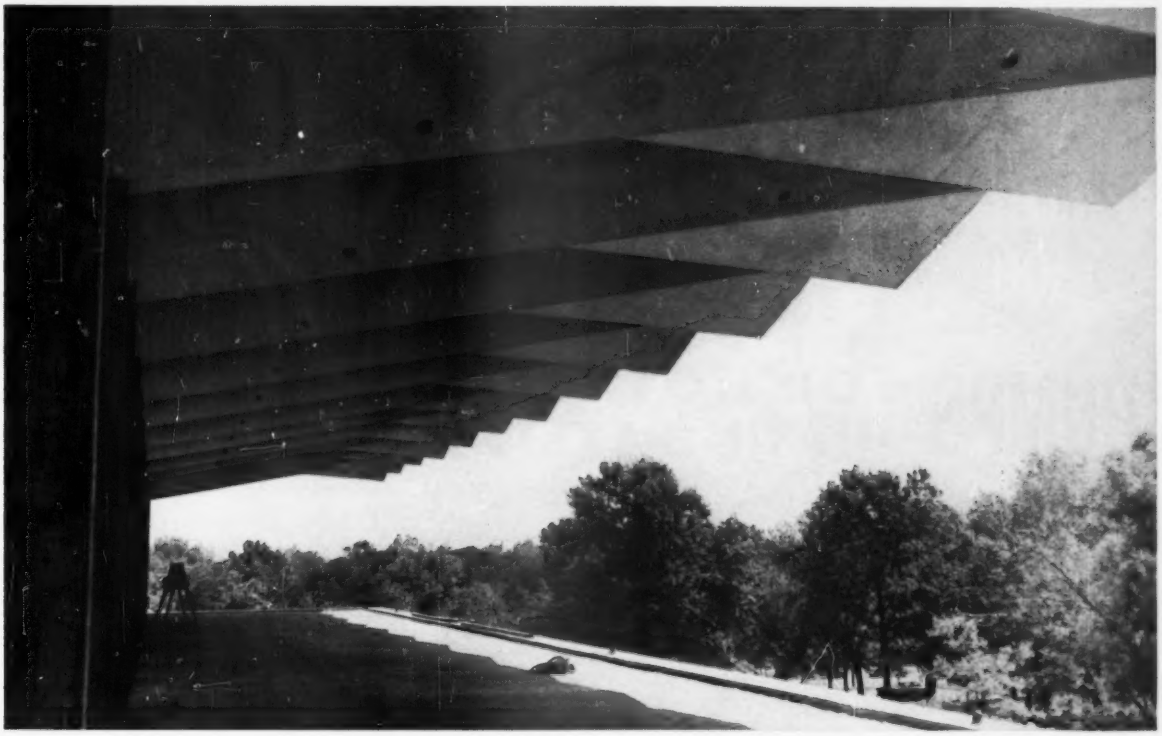
A light beam from a searchlight is reflected by the clouds to a photocell placed at a known horizontal distance from the search-



STEINBERG MEMORIAL

Hall of Art and Archaeology
Washington University, St. Louis

General Contractor: G. L. Tarlton Contracting Co.
Architect: Russell, Mullgardt,
Schwartz and Van Hoefen
Structural Engineers: Eason, Thompson Associates



An Interesting use of Concrete...
STRENGTHENED with LACLEDE REINFORCING STEELS

In today's bold new architecture, concrete has become a medium of artistic expression, rather than a mere structural material.

This dramatic building by Russell, Mullgardt, Schwartz and Van Hoefen is a superb example. Intersecting concrete planes form an interesting pattern of shades and shadows against the severe vertical lines of the limestone walls.

Notice the 20-foot overhang in the photograph. Design like this would be impossible without the inherent strength of concrete, reinforced with specially designed high-strength steels.

In Steinberg Memorial, this strength is provided by Laclede reinforcing steels.

Laclede reinforcement is finding its way into more and more concrete structures these days—buildings, highways, bridges, grain elevators and many others. It's the ideal material for providing the strength needed for durability and long-lasting service.

LACLEDE

LACLEDE STEEL COMPANY

SAINT LOUIS, MISSOURI ◆ Producers of Steel for Industry and Construction

light. The cloud height analyzer uses the data collected in this fashion to automatically supply complete cloud information.

Unions Already Campaigning

Some of the country's most powerful unions already have kicked off what promises to be a slam-bang political campaign next year. Their purpose, of course, is to elect their friends and punish their enemies. COPE (Committee On Political Education), the political arm of the AFL-CIO, admits that the campaign, for all practical purposes, already is under way. Furthermore, it warns it may be choosy in 1960 about the candidates it supports.

Politicians might well give heed to the fact that trade union support should not be taken for granted. In an effort to show that it means business, COPE is urging local union officials to buy a 19-minute film designed to show how to get the maximum use out of the telephone in getting out the vote for union-backed candidates.

Meantime, the unions have earmarked 54 House members for defeat in next year's elections. The group includes 52 Republicans and two Democrates.

Power Co-ops Into Politics?

Because he is threatening to put the public power cooperatives into active politics, some members of Congress are lashing out at Clyde Ellis, general manager of the National Rural Electrification Cooperative Administration. Representative Richard M. Simpson, Republican of Pennsylvania, has advised Ellis that his proposal to put the cooperative groups into politics would reflect unfavorably on the Rural Electrification Administration with matters before the United States Congress.

ABC Highway Program Growing

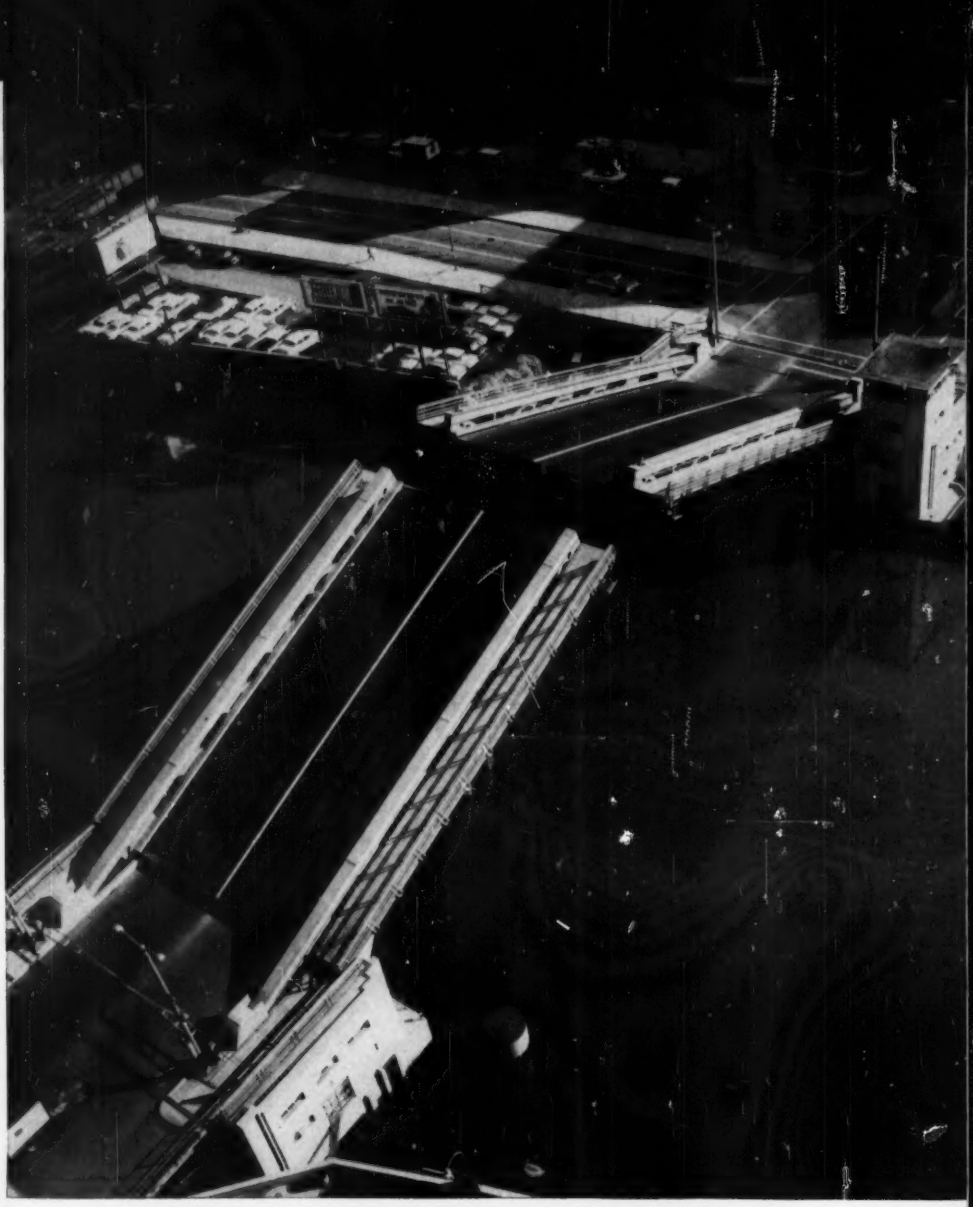
The so-called ABC highway program where the Federal government puts up 50 percent of the cost and the states 50 percent, is showing a steady growth. The primary system has grown from 169,000 miles in 1923 to more than 256,000 miles. The secondary system has grown from 137,000 miles in 1944 to more than 554,000 miles.

Fewer Government Secrets?

The Eisenhower administration has agreed to work with the U.S. Chamber of Commerce to get more information to American business and professional men. President Eisenhower concurred with the Chamber proposal in the hope that it will aid in getting pertinent, factual, nonclassified information more widely circulated. It is hoped, particularly in engineering fields, that this will bring more rapid practical application of basic theory, a process in which the Russians presently seem to excel. (For further commentary on application of theory see John F. Lee's "Atoms in Action" column, starting on page 150.)


New
Chicago
movable bridge
first with
Westinghouse
a-c static control
YOU CAN BE SURE... IF IT'S Westinghouse

COVER PHOTO: View at West Van Buren Street Bridge, Chicago, showing leaf rack, pinion and main drive gearing operated by Westinghouse Bridg-O-Matic control to raise and lower east leaf of bridge.

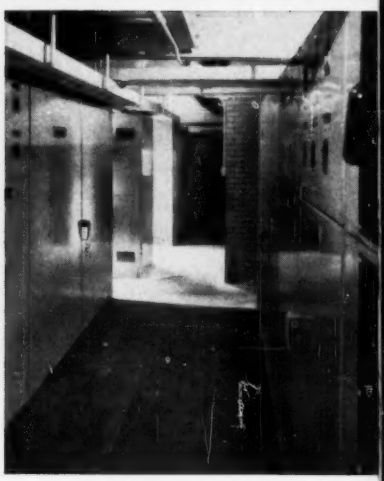


Double leaf, trunnion bascule bridge opening for Chicago River traffic. One man in operator's room, East Pier, upper right, controls the bridge by means of an all a-c system employing Westinghouse saturable reactor-type controller.

J-94132-2

W. C. Carl, Construction Engineer, Westinghouse (standing), discusses Bridg-O-Matic drive with Stephen J. Michuda, Chief Bridge Engineer, City of Chicago, at right, and his staff (left to right): S. Frayer, Structural Engineer; M. D. Krausman, Assistant Chief Bridge Engineer; and R. H. Keil, Electrical Engineer, Bridge Division.

Stephen J. Michuda; M. B. Trimble, Construction Sales Engineer, Westinghouse; and William G. Divane, President, Divane Brothers Electric Company, Electrical Contractors, discuss main control desk which centralizes operation of leaf and auxiliary drives and selection of east and west incoming service feeders. Instruments on sloped panel indicate leaf position and electrical circuit conditions.



View of switchboard room showing incoming line switching equipment, magnetic control for auxiliary drives, Bridg-O-Matic wound rotor motor control panels and saturable reactor cubicles. Robert E. O'Brien, Chief Electrician, examines panel containing emergency control switching equipment at far end of room.

Westinghouse Bridg-O-Matic Control specified to operate Chicago's West Van Buren Street Bridge

An important factor in the design of the West Van Buren Street movable bridge in Chicago was the selection of the most efficient drive and control system available. Westinghouse Bridg-O-Matic* control was specified after a study of its advantages over other types of control.

The West Van Buren Street Bridge is a double leaf, trunnion bascule bridge across the south branch of the Chicago River and is designed to carry vehicular and pedestrian loads. Each bridge leaf is normally operated by two 100-hp a-c wound rotor induction motors. For emergency operation, a single motor per leaf may be used. During normal operation, the time required to open or close the bridge is approximately 55 seconds. Four electrically operated thrustor brakes are provided for holding each leaf in the desired position. Minimum brake shoe lining wear is encountered since the leaves are normally retarded by the motors through the action of the static reactor/Magamp controller to a low speed before the brakes are caused to set.

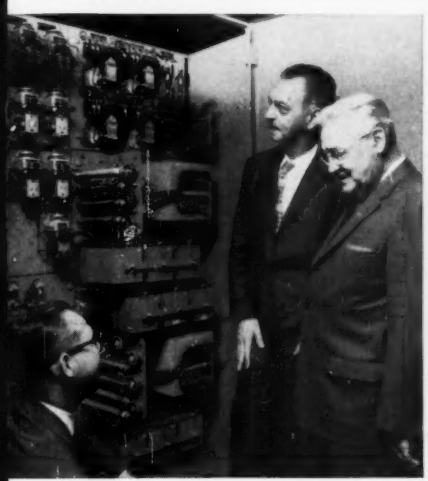
The normal control of the two operating motors for each leaf, connected for parallel operation, is by means of the Bridg-O-Matic control (a-c reactor control system). The speed torque performance of this system provides precision operation under all conditions of leaf load from normal to a 10-lb wind, without the use of any "mechanical" braking, for positive slowdown and reduced speed operation.

Electric power, supplied by two independent networks, is three phase, four wire, 60 cycle at 208/120 volts, stepped up at the bridge through transformers to 480 volts.

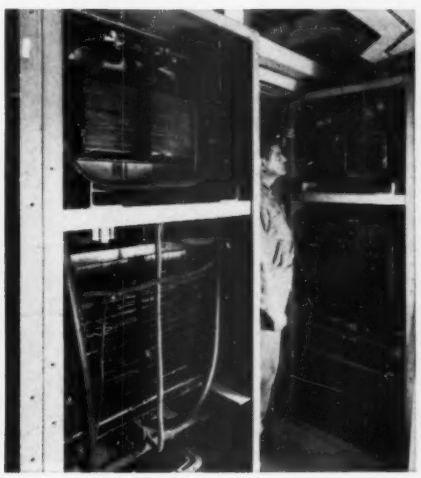
An alternate control system may be selected by moving the control selector switch from "Reactor" to "Off." This provides the conventional reversing wound rotor controller with six power points and a drift point. Either motor may be used. *(contd.)*

*Trade-Mark

J-94132-3

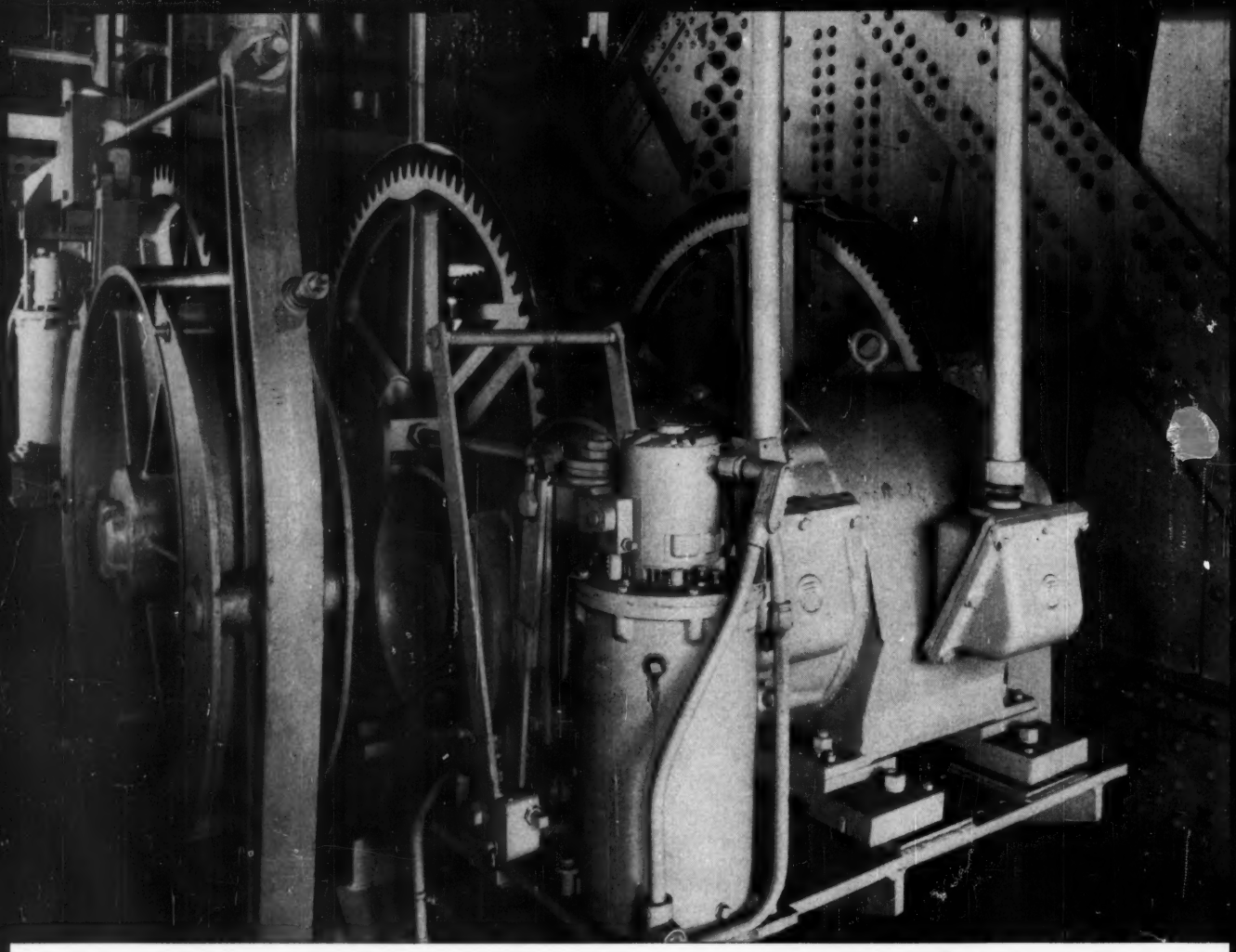


L. A. Johnson, Westinghouse Sales Engineer; E. A. Leske, Electrical Engineer, Divane Brothers Electric Company; and R. H. Keil inspect Westinghouse Magamp control section of bridge switchboard.



Chief Electrician, Robert E. O'Brien, checks cubicles which house Westinghouse primary saturable reactors.

Incoming line cubicle of bridge control (switchboard room, East Pier) is inspected by W. C. Carl; Edward Klausner, Engineer in Charge of Bridge Construction; and R. H. Keil.



View showing one of leaf drives (there are two per leaf), each with Westinghouse 100-hp a-c wound rotor motor and a-c thrustor-operated motor and machinery brakes.

Westinghouse Bridg-O-Matic operates Van Buren Street Bridge (contd.)

Interlocks are provided in the control system to prevent operation of leaves until all flashers, traffic lights, gongs and warning horns are operating, traffic gates are down, and bridge centerlocks are withdrawn.

Westinghouse saturable reactor a-c systems offer many possibilities for vertical lift, bascule or swing bridge designs, and other applications such as dam and lock gates, cranes, hoists, etc. For more information call your Westinghouse electrical construction engineer, or write: Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. J-94132-4

OWNER & DESIGNER: City of Chicago, Ill.
Department of Public Works, Bureau of Engineering
Division of Bridges and Viaducts

CONSULTING ENGINEER: Hazelet & Erdal, Louisville, Ky., and Chicago, Ill.

ELECTRICAL CONTRACTOR: Divane Brothers Electric Company, Chicago, Ill.

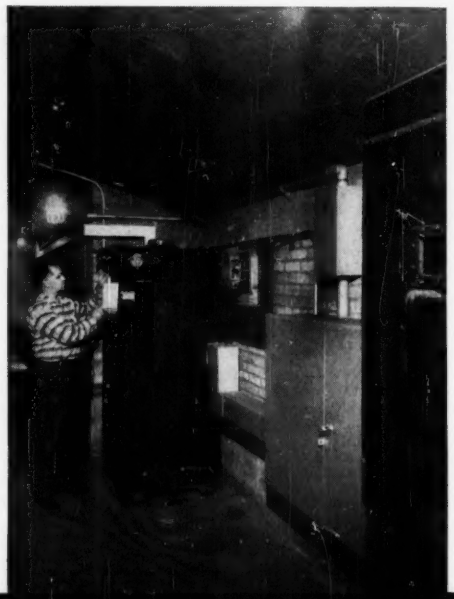
SUPERSTRUCTURE-MACHINERY CONTRACTOR:
Overland Construction Company, Chicago, Ill.

STEEL FABRICATOR: American Bridge Division, United States Steel Corporation, Pittsburgh, Pa.

YOU CAN BE SURE...IF IT'S **Westinghouse**

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV FRIDAYS

John A. Machiels, Bridge Maintenance Machinist, looks at the 225-kva Westinghouse Inerteen®-filled step-up transformer which provides 480-volt supply for bridge drive motors and auxiliaries. Type DB-50 wall-mounted circuit breaker provides main feeder protection.



News for the Consultant

Seven New Alpine Tunnels

With the initiation of work on the French section of the Mont Blanc road tunnel recently, it is still possible that the world's longest road tunnel will be finished on schedule, sometime late in 1961. Work was started on the Italian end of the tunnel in late 1958. It will be seven miles long compared with the five-mile bore across the straits of Kwannon, Japan, between the islands of Horshu and Kyushu, the present longest.

Six other road tunnels are planned to penetrate the Alpine massif, one already started, another about to start, and the rest to follow. These are:

¶ Col de la Croix – 2 miles, all in France, to join Turin, Italy, and Marseilles, France. Estimated cost $5 million.

¶ Grand St. Bernard – 3.6 miles, between Italy and Switzerland, also carries an oil pipeline from Genoa. Work has started with completion due in 1961. Estimated cost $7.9 million.

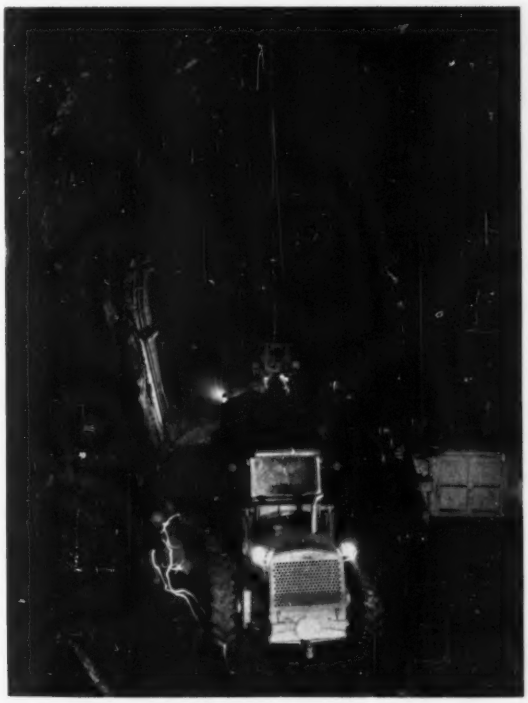
¶ San Bernardino – 4 miles, all in Switzerland, joining Switzerland and Italy. Work is about to start with completion scheduled sometime in 1961. Estimated cost $10.1 million.

¶ Splugen – 5 miles, between Italy and Switzerland, linking Zurich and Basle, Switzerland with Milan, Italy. Estimated cost $20 million.

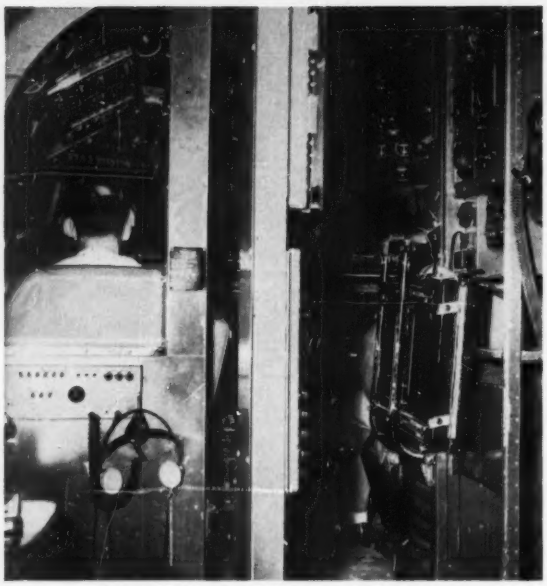
¶ Stelvio – preliminary engineering estimates have not been released yet. However, it will link Italy with Switzerland, Austria, and Central Europe.

¶ Brenner – 14.3 miles in two sections, one of 10 miles from Steinach to Colle Isarco and the other

Ventilation duct hung from Mont Blanc tunnel roof.



Mucking in Mont Blanc tunnel. Note iron framework.



Interior view EAL DC-7 B simulator.

of 4.3 miles from Colle Isarco to Vipitano, linking Italy and Austria. Estimated cost $75 million.

There is another tunnel on the planning boards of European engineers. This is the one to penetrate the Alps below the present St. Gothard railroad tunnel, which is at present the shortest connection between central Europe and the south. This tunnel, which will be a three-decker, is to be 10 miles in length. It was fully described in the December 1958 issue of CONSULTING ENGINEER.

New Incinerator Features Automation

A new type of municipal incinerator that burns up to 12½ tons of refuse an hour is now serving 50,000 residents of two Pennsylvania communities.

Operating personnel are limited to a supervisor, who controls the entire incinerator process operation; a weighmaster-loader; a conveyer operator;

Waterwall being installed in Whitemarsh, Pa. incinerator enables daily shutdown without long cooling off periods.

and a man to load and drive a truck that carries off noncombustibles. The plant has a 24-hour capacity of 300 tons but it is burning only about a third of the time, operating on one eight-hour shift.

One of the unusual features of the plant that makes part-time operation practical is the use of a waterwall, which circulates cooling water immediately inside the fire brick refractory. Besides the

Nothing takes a bigger beating than your floors . . .

Only Masterplate floors take this terrific traffic

. . . 200,000 trips a year over aisles at Lincoln Electric

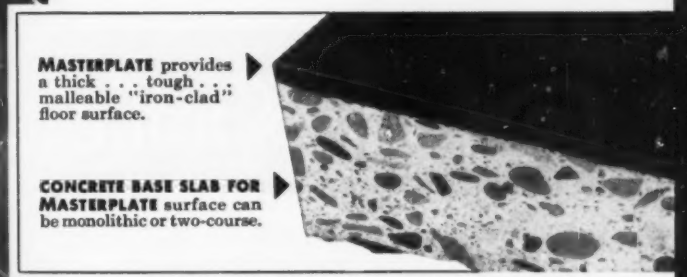
To withstand heavy fork-lift truck traffic—The Lincoln Electric Company's 30-acre plant uses MASTERPLATE floors in its material transfer aisle. MASTERPLATE "iron-clad" floors provide a thick, tough, malleable surface that can take this day-in, day-out beating.

With MASTERPLATE—Lincoln's high-volume production flow of welding machines and electrodes is not interrupted by costly downtime for floor repairs or replacement.

MASTERPLATE . . . and the on-the-job services of the Master Builders field service team . . . is your key to floors that last *4 to 8 times longer than the best plain concrete floor.* They pay for themselves again and again.

On any current or future floor projects, the local Master Builders field man will welcome discussing your requirements. Call him in. He's at your service. Write us for complete information.

The Master Builders Company, Cleveland 3, Ohio
Division of American-Marietta Company
The Master Builders Co., Ltd., Toronto 15, Ontario
International Department, New York 17, New York
Branch offices in all principal cities.



MASTERPLATE provides a thick . . . tough . . . malleable "iron-clad" floor surface.

CONCRETE BASE SLAB FOR MASTERPLATE surface can be monolithic or two-course.

FOR FINISHING NEW CONCRETE FLOORS or re-surfacing old concrete floors—MASTERPLATE withstands impact . . . is oil resistant and virtually non-absorbent . . . easy to clean . . . resistant to many industrial corrosives and strong cleansers . . . *and outwears the best plain concrete floor 4 to 8 times according to tests by top independent testing authorities.*

2-MINUTE TIME EXPOSURE—using "tracer lights"—shows typical continuous, heavy floor traffic pattern over MASTERPLATE floor at Lincoln Electric Co., Cleveland, Ohio—world's largest manufacturer of arc welding equipment.

MASTER BUILDERS® MASTERPLATE*

*MASTERPLATE *is a registered trademark of The Master Builders Co. for its specially prepared, metallic aggregate for producing "iron-clad" concrete floors.*

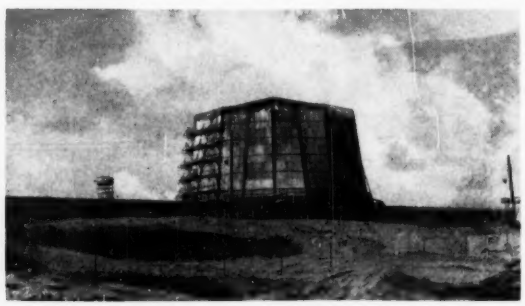
obvious advantages of keeping the furnace walls below the normal slagging point of refuse ash and of permitting material to burn at high temperatures assuring complete combustion and odor elimination, the water-wall makes possible shutdown of the furnace without the long cooling-off period usually necessary to prevent deterioration of the refractory.

The plant was built for the Whitemarsh Township Authority with Glace and Glace, Inc., of Harrisburg, Pa., as consulting engineers.

Another Dome

Although not a true spherical dome, the unusual design approach for this building housing a swimming pool type nuclear reactor warrants mention. Limited construction techniques and availability of material were the controlling factors. Lev Zetlin, a consulting engineer, from New York, and Philip Johnson, an architect, also from New York, joined in developing this unique concrete structure, the location of which is classified information.

The entire shell is 4-inches thick, reinforced with ¼-in. bars spaced every 8 inches. Brackets projecting from the walls of the dome support a ring girder which carries a rotating 25-ton crane. The whole dome, therefore, is subjected to torsional forces in the horizontal plane in addition to the other in-

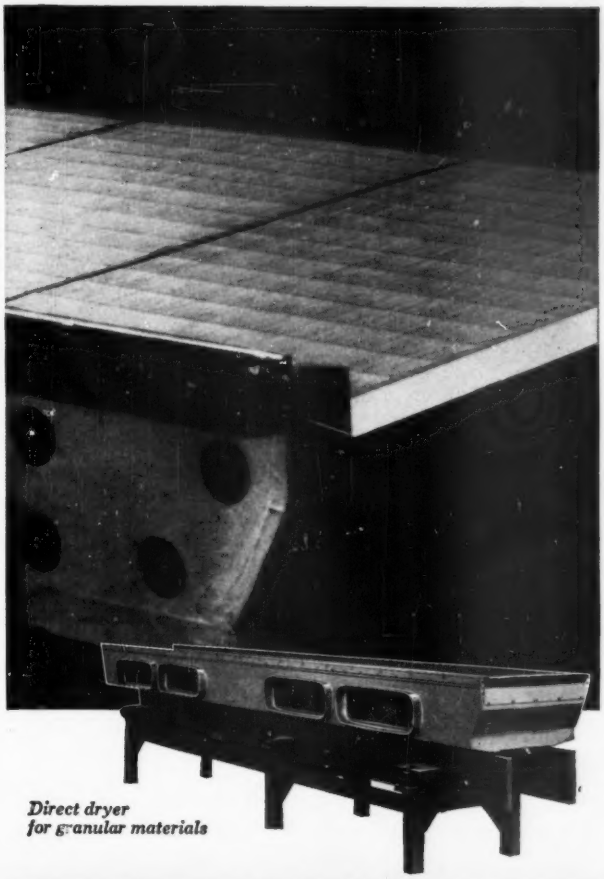


Use of hyperbolic paraboloid walls contributes to the clean lines of this unusual nuclear reactor dome. Reactor is swimming pool type.

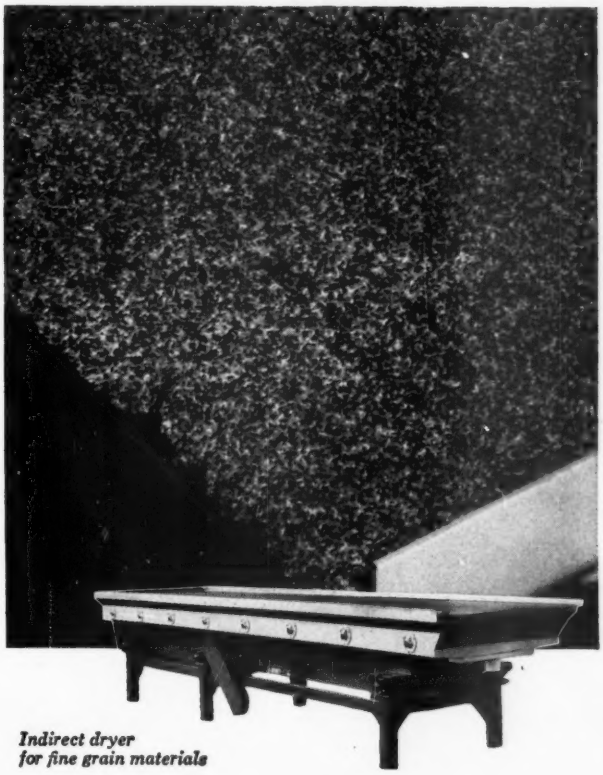
herent stresses. It has a clear height at the center of about 50 feet and its diameter is 80 feet.

The slanted hyperbolic paraboloid walls were adopted for both aesthetic and economic reasons, one of the latter being ease of construction, utilizing straight boards for formwork. However, there is almost no information available for the design of hyperbolic paraboloids subjected to loads parallel to their own plane as in this structure. Zetlin, therefore, developed his own design formulae for this particular shell starting from the basic stress function. ▲▲

*"MASTERPLATE is a registered trademark of The Master Builders Co. for its specially prepared, metallic aggregate for producing "iron-clad" concrete floors.



Direct dryer for granular materials



Indirect dryer for fine grain materials

Continuous drying or cooling at less cost!

New Jeffrey units feature variable-amplitude mechanical vibrating drive

Now proved in service, Jeffrey's new line of mechanical drive dryers is demonstrating lower maintenance and operating costs, in addition to savings in initial investment. Yet these dryers offer the same operating advantages as electric vibrating systems—variable amplitude drive permits adjusting speed of travel and depth of material as desired. Operation is fully automatic; heat transfer is fast and efficient.

These machines may be used for either drying or cooling and are available in direct or indirect types. They are built in standard lengths of 10 or 20 feet. A tailor-made installation can be assembled from standard components.

The direct dryer is designed to carry granular materials, in the range of ¼" down to about 60 mesh, on a stainless steel conveying surface through which drying air or gas is passed. The indirect type dryer carries very fine grain materials on a solid plate conveying surface, heated from below by low pressure steam or heated air.

Investigate this new cost cutter. For information write, The Jeffrey Manufacturing Company, 822 North Fourth Street, Columbus 16, Ohio.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT
...TRANSMISSION MACHINERY...
CONTRACT MANUFACTURING

USS TIGER BRAND — AMERICA'S NO. 1 WIRE ROPE

607,000 cubic yards of concrete delivered by

SUTTON DAM—One of the largest flood control dams in eastern United States, located on the Elk River about 80 miles from Charleston, West Virginia. Designed and built under the direction of U.S. Army Corps of Engineers, Huntington, West Virginia. Contractors: Joint venture between Arundel, Dixon-Hunkin. General Superintendent for contractors, Jay Hay; Project Engineer, Ed. Hahn.

"air express" on USS Tiger Brand Tramway Cable

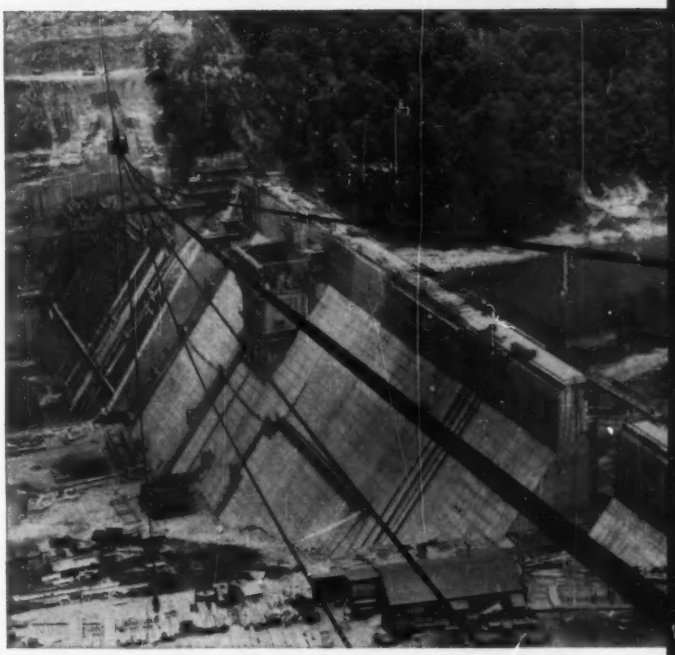
Every 3½ minutes this cableway bucket pours another load of "mud" into the mammoth Sutton Dam near Charleston, West Virginia. They're pouring at the rate of 9,000 cubic yards a week—fast time for one 8-yard bucket. When finished, the dam will contain about 607,000 cubic yards of concrete.

The main "gut" is a Tiger Brand 3-inch Locked Coil Tramway Cable 1,700 feet long. It stretches between one fixed tower and one *moveable* tower so that the bucket can reach any part of the dam. This cable was bought new for the job and from all indications will still be serviceable when the dam is completed. Other Tiger Brand Locked Coil Cables have been used on two or more big dams before replacement was necessary.

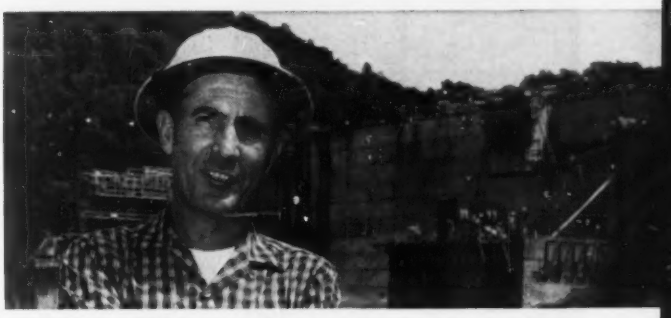
All over this project, Tiger Brand Wire Rope is doing a stupendous job. On one of the more critical applications, a 3,920-foot endless rope is used to pull the carriage assembly. Because of the hard wear this particular rope must take, they used a 1⅛" 6 x 30 flattened strand rope made of tough Monitor Improved Plow Steel.

Tiger Brand Wire Rope was also used for the hoist line, button line and take-up line, largely because of its excellent performance on previous dams such as Mt. Morris and Shasta. Mr. Lamar Pearce, Cableway Superintendent, who has had a world of experience on big dams, uses Tiger Brand more than any other make. For more information on wire rope, write American Steel & Wire, Dept. 9348, 614 Superior Ave., N.W., Cleveland 13, Ohio.

USS and Tiger Brand are registered trademarks



Main Gut—USS Tiger Brand 3-inch Locked Coil Cable with smooth surface for efficient operation. Interlocked construction holds each wire in its proper position.



Lamar Pearce, Cableway Superintendent, who knows from experience that Tiger Brand Wire Rope is safe and dependable.

Why Tiger Brand is your best buy

1. It is made by a company that maintains the most complete research and manufacturing facilities in the steel industry.

2. It is designed by one of the country's most capable staffs of wire rope engineers. It is serviced by thoroughly experienced field representatives always ready with their assistance.

3. Every type of Tiger Brand Wire Rope is designed for specific applications. *You* get the *right* rope for the job.

4. It is made by *one* company, U.S. Steel, and every step of production from ore to finished product is carefully controlled and supervised to guarantee *one* high standard of quality.

5. Tiger Brand Wire Rope is manufactured by the foremost single wire rope producer in the country.

Concrete delivered by aerial cableway—the cheapest and fastest way to haul materials needed for the dam.

American Steel & Wire Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors
United States Steel Export Company, Distributors Abroad

Men in Engineering

Bird, Bird and Associates, consulting mechanical and electrical engineers, have opened a branch office at 618-2nd Street, South, St. Cloud, Minnesota. The firm will continue to maintain its main headquarters in Osseo, Minnesota.

Roy C. Neumann, formerly with Sargent, Webster, Crenshaw & Folley, Schenectady, New York, has been named deputy director of architecture of A. M. Kinney Associates, Architects & Engineers, Cincinnati, Ohio and New York, New York.

A new consulting engineering firm, Clapsaddle Engineering Company, has been formed with offices in Conrad, Iowa. Principal of the new firm, Jack L. Clapsaddle, formerly was a partner of Thompson, Willis, and Clapsaddle.

John E. Plantinga has become a general partner of Meyer Strong & Jones, consulting engineers of New York City.

Marks A. Levy and Fred H. Markus, formerly with Neiler, Rich and Bladen, have formed a partnership for the practice of engineering to be known as Consulting Associates, with offices at 845 So. Wabash Avenue, Chicago, Illinois.

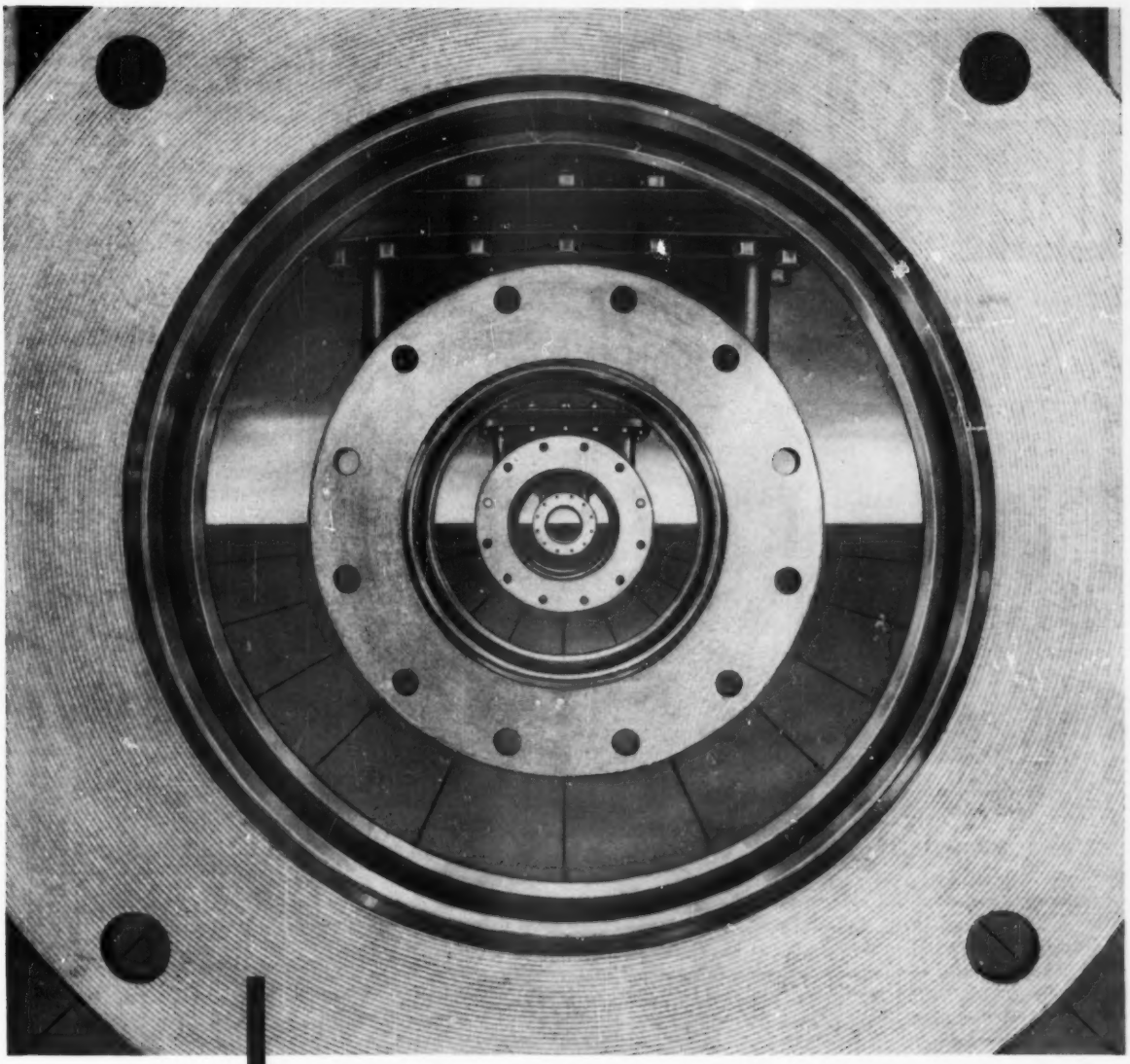
B. J. Greulich, structural engineer, has become a partner of Hugh B. Brewster, Structural Engineer, Fresno, California. For the past 20 years, Greulich has been employed by Midstate Construction Company of San Francisco and Fresno as an engineer and construction estimator for all types of construction.

William G. Hamlin, sanitary engineer specializing in waste control, has joined the training program staff of Robert A. Taft Sanitary Engineering Center, Public Health Service, in Cincinnati, Ohio. He will assist in formulation and presentation of specialized technical training courses in the water supply and water pollution field. For several years Hamlin has been in private practice and most recently had completed for Alfred Le Feber and Associates, consulting engineers, Cincinnati, an engineering investigation and report on the combined sewage and industrial waste problem of Greendale, Indiana.

HAMLIN

NISSLEY

Harold Nissley, consulting engineer and arbiter, Cleveland Heights, Ohio, is in Japan to hold a series of seminars with Japanese consultants who are anxious to help their client companies do a better job. This is Nissley's fourth experience with



Through these Gate Valves pass the best-regulated streams in the World!

The sound design and quality workmanship of Ludlow gate valves and Rensselaer gate valves is a guarantee of *lasting* ease of operation. Watertight closure is assured through years of trouble-free performance.

Write for the L&R Gate Valve Catalogs, showing the most complete selection of outstanding design features available today. Ludlow and Rensselaer double disc gate valves meet all requirements, including A.W.W.A. specifications, in sizes from 2″ to 72″, plus custom designing for special applications.

LUDLOW & RENSSELAER

VALVES AND HYDRANTS

THE LUDLOW VALVE MANUFACTURING CO., INC., TROY, N. Y. – SINCE 1861

foreign engineers and executives, the first being in Berlin, with the Osram Company during the summer of 1956. Nissley will be back in this country early in January to resume his consulting and arbitration practice. His wife is with him on his eight-week tour of duty in the East.

Harry J. Scharres, partner in the firm of E. R. Gritschke and Associates, Chicago, has been appointed to the Commission on Chicago Architectural Landmarks by Mayor Richard J. Daley. The purpose of the commission is to identify Chicago architectural landmarks and to act in the interest of preserving and publicizing such landmarks for the benefit of the people.

SCHARRES ALLSHOUSE

Robert L. Allshouse, superintendent of construction for Stone & Webster Engineering Corporation in Texas and Louisiana, has been named a construction manager of the world-wide organization and transferred to the Boston headquarters. Allshouse has been in charge of construction of central power stations with a total capacity of more than 750,000 kw in Texas and Louisiana for the Gulf States Utilities Company.

Omer J. De Bever, formerly chief electrical engineer for Charles Luckman Associates, has established a consulting electrical engineering office in Los Angeles. The firm will be known as Omer J. De Bever & Associates with offices at 2872 Rowena Avenue. The new firm will provide electrical consul-

the bolt on the right is new

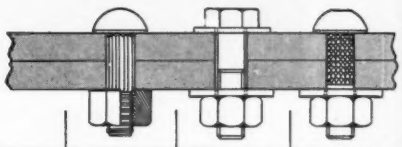
LAMSON HIGH STRENGTH BEARING BOLT*

Combines the tensile strength of a hex head high strength bolt with the bearing of a rivet.

Has the highest shear strength and greatest resistance to slip of all structural bolts.

Costs the same as the Lamson Dardelet Rivet Bolt (left) and the Lamson High Strength Bolt (center).†

COMPARISON TABLE



	DARDELET RIVET BOLT	HIGH STRENGTH BOLT	HIGH STRENGTH BEARING BOLT
ASTM designation	none	A 325	A 325
Comparative shear strength (⅞" Dardelet=100%)	100%	159%	177%
Tensile strength	70,000 lbs.	90,000 to 120,000 lbs.	90,000 to 120,000 lbs.
Resistance to slippage	good	fair	excellent
Resistance to vibration	good	good	excellent
Men required to install	one	two	one
Equipment required	sledge and hand wrench	impacter and hand wrench	maul and impact wrench
Installation cost	equal to or less than rivets	less than rivets	less than rivets
Washers required	none	two	one

Size for size, this new bolt costs the same as the other two, yet provides a more rigid structure at less cost. Field tests have proved its superiority, and already many structures have been erected using this bolt.

The new Lamson High Strength Bearing Bolt is available now through 20 U. S. Steel Supply Division Steel Service Centers in key locations throughout the country.

Write Lamson & Sessions for Bulletin HSBB. Contains pertinent engineering data. Firm names, and locations where these bolts have been used, will be mailed promptly on request.

**Pat. App. for*
†Cost based on using bolts with nuts and washers as shown.

LAMSON & SESSIONS

5000 TIEDEMAN ROAD • CLEVELAND 9, OHIO

Plants in Cleveland and Kent, Ohio • Chicago and Birmingham

tation and engineering design service to architects, engineers, contractors, commercial and industrial firms, and government agencies.

At the annual convention of the American Society of Civil Engineers held recently in Washington, D.C., the Ernest E. Howard Award was presented to Dr. D. B. Steinman. The citation accompanying the gold medal stated that the honor was conferred upon Dr. Steinman "for his signal contributions towards the advancement of bridge analysis and design, to the theory of the suspension bridge and its aerodynamic stability, and especially for his outstanding work in the design of the Mackinac Bridge."

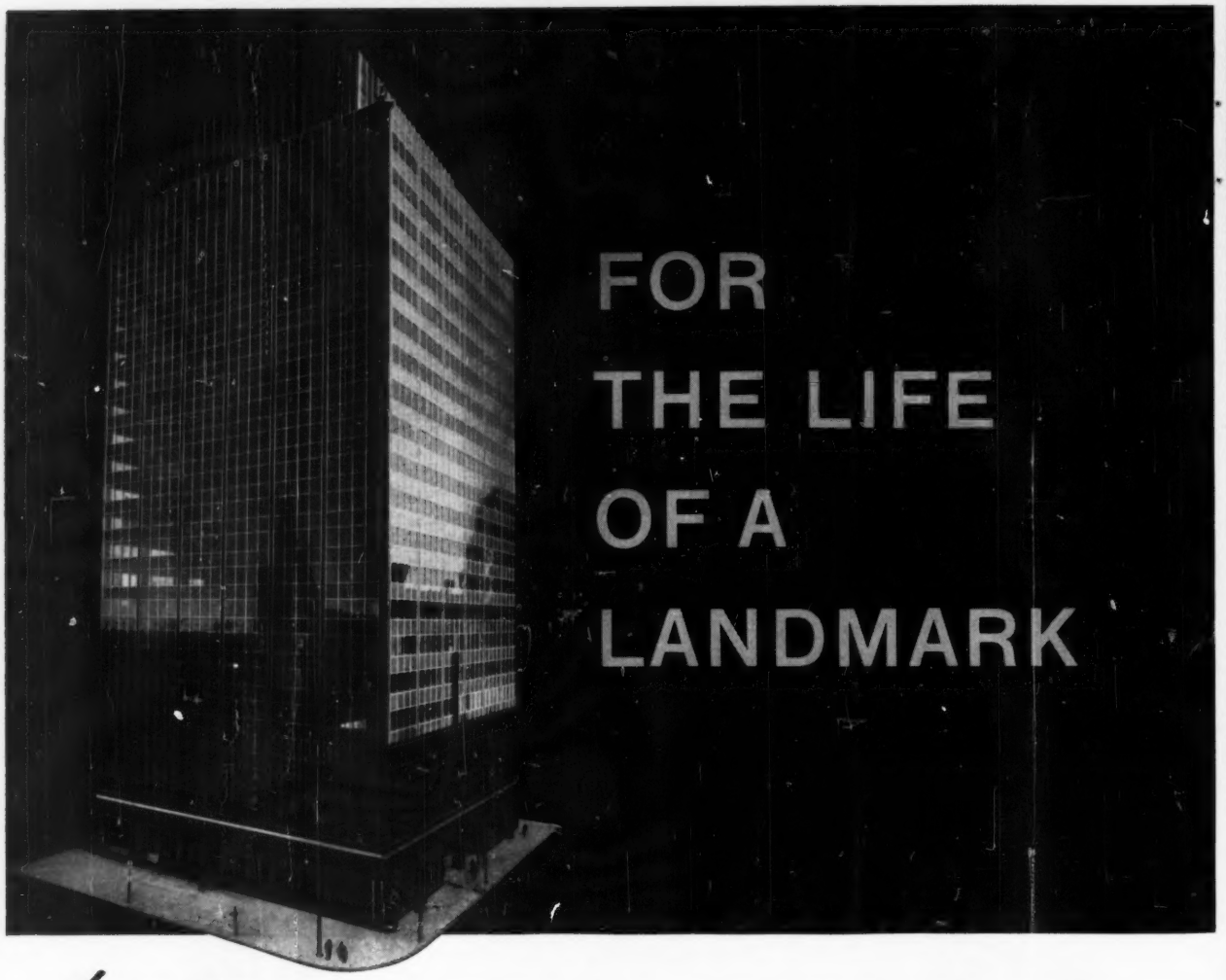
Deba Prasad Nath has joined the staff of Harland Bartholomew and Associates, Consulting City Planners, of St. Louis. Nath, a town planner, is on leave from the Town Planning Department of the government of the State of Assam in India. Nath will be with Harland Bartholomew and Associates for 1½ years, after which he will return to his position with the Government of Assam.

Marvin G. Sturgeon has been advanced to vice president and director of engineering for Charles Luckman Associates, planning-architecture-engineering firm of Los Angeles and New York, Sturgeon joined the Luckman organization as a vice president in January 1959. Prior to 1959 he was director of public works for Ventura County, California, where he planned and supervised the public works activity including roads, subdivision improvements, public buildings and parks, engineering, water supply, flood control and drainage, harbor, surveying, and building inspection.

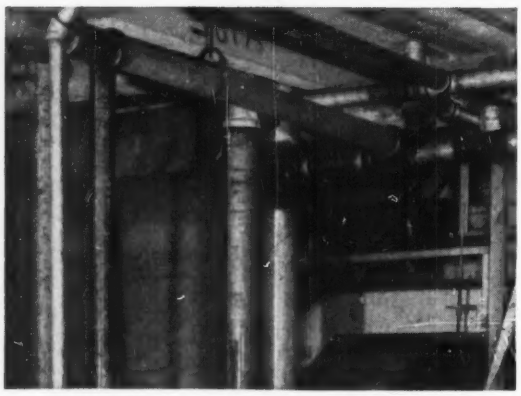
STURGEON BUCHHAGEN

W. H. Buchhagen, president of Bucknell Engineering Company, Pittsburgh, has been elected president of the Pennsylvania Association of Consulting Engineers.

Atlantic Research Corporation of Alexandria, Va., has completed negotiations that will make Jansky & Bailey, Inc., of Washington, D. C., a wholly-owned subsidiary. The transaction also gives ARC a substantial stock interest in General Communication Co., of Boston, which currently owns Jansky & Bailey. Jansky & Bailey will continue under its present policies and technical management, with Messrs. Jansky and Bailey retaining their present positions. ▲▲



Long-term economy...160 tons of Republic Steel Pipe installed in Cleveland's East Ohio Building



EAST OHIO BUILDING SPECIFICATIONS called for 160 tons of 1½" through 12" steel pipe for waste and vent lines. Installation was handled by Gorman-Lavelle Plumbing & Heating Company, Cleveland, Ohio. Architects: Emery Roth & Sons. General Contractor: Tishman Construction Company.

Galvanized Steel Pipe. *Republic* Pipe. Good for the life of any building. Good for the life of this new, 22-story, Cleveland *landmark*.

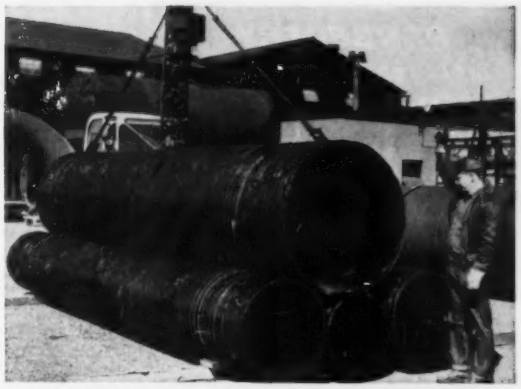
Steel pipe for *economy*. Immediate or long-term. Costs less. And for uniformity . . . *Republic*. Easier bending, cutting, threading, welding. Expect faster installation . . . fewer costly delays.

Trust the great strength of steel for long, unsupported runs . . . the availability of steel pipe for minimum variation in delivery . . . the tight, galvanized coating of *Republic* Steel Pipe for resistance to corrosion and fabrication damage.

Get the *facts*. Your Republic distributor has them. Call him for complete information on the immediate and long-term economies that are yours with Republic Steel Pipe. Or, mail the coupon.

MAXIMUM FLOW, MINIMUM DIAMETER...

In comparable sizes, Republic FREE FLOW Sewer Pipe with smooth, asphalt interior lining offers greater capacity than ordinary culvert. Non-spalling interior provides excellent corrosion- and erosion-resistance. Furnished in long sections. Half-bands are imbedded in asphalt and bolted to provide tight, leak-proof joints that won't pull apart. Sections are strong yet flexible, adjust to loads without damage. Send for details.

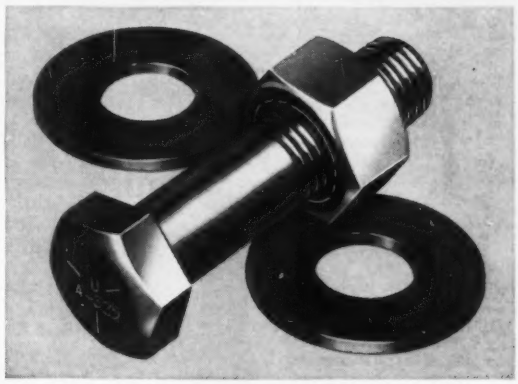


SHARP, FREE-RUNNING THREADS...

Ease of threading is a characteristic of Republic Rigid Steel Conduit—made of soft, ductile steel, and produced by the continuous weld process. Unsurpassed uniformity and ductility assure easy bending, easy installation. Welds are sound, smooth, and strong. Surface is fully protected by a galvanized coating that will not peel, flake, or chip off under normal bending. Return the coupon for data.

VISE-LIKE CLAMPING FORCE...

Specify Republic High Strength Bolts for powerful clamping action that transfers loads to the structural members themselves. Fatigue life is improved to the point where it need no longer be a design consideration. Republic High Strength Bolts are far stronger than comparable size rivets. Fewer are needed to support equal loads. Mail the coupon below for complete information.



REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

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1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Please send more information on:

☐ Galvanized Steel Pipe ☐ High Strength Bolts
☐ Rigid Steel Conduit ☐ FREE FLOW Sewer Pipe

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

New Projects Reported

By Consulting Engineers

ALABAMA

Donald Mills, Consulting Engineer
Selma, Alabama
¶ Sewerage extensions, pumping stations, and treatment plant; capacity 0.25 mgd, Town of Robertsdale, Ala. (civil) $300,000. Client, Town of Robertsdale.
¶ Natural gas system, Loxley, Ala. (civil) $200,000. Client, Town of Loxley.

ARIZONA

William B. Keller, P.E.
Phoenix, Arizona
¶ Grandview Plaza shopping center, Phoenix, Ariz. (elec.) $980,000. Client, Verner Land & Development Co.
¶ Deer Valley airport, Phoenix, Arizona (elec.) $100,000, Client, F. Fazio & Associates.
¶ Salvation Army hospitality house, Phoenix, Ariz. (elec.) $135,000. Client, F. Fazio & Associates.

CALIFORNIA

William H. Kirkgaard
Glendora, California
¶ Three concrete frame highway bridges spanning floor control channels. (struc., civil) $120,000. Client, Azusa, Calif.

John R. Anderson, Structural Engineer
Pasadena, California
¶ Precast tilt-up concrete building, 26,000 sq ft, with composition roof, plywood sheathing, wood rafters and purlins, tapered steel girders and carrying girders and isloated spread footings. Building includes office area, toilet facilities, monorail system. Owner and occupant, Anjac Manufacturing Co., Inc., El Monte, Calif. (struc., civil) $140,000 (est.) Client, D. F. Shaw, General Contractor.
¶ Precast tilt-up concrete addition, 43,500 sq ft, with gravel roof, plywood sheathing, wood rafters and purlins, tapered steel girders and friction piles. Owner, Reliable Steel and Builders Supply Co., Los Angeles, Calif. (struc., civil) $170,000. Client, D. F. Shaw, Gen. Contractor.
¶ Office building, two-story, 2500 sq ft on each floor. Walls of concrete block and concrete screen block, composition and gravel roof, plywood sheathing on wood rafters, steel beams carrying rafters. Floor is plywood deck on wood floor joists, supported on steel beams. Footings are isolated spread footings and continuous wall footings. Lessee is Hancock Insurance Co., San Diego, Calif. (struc.) $60,000. Client, G. F. Schreiber, Arch.

W. E. Barney
Pasadena, California
¶ Steel water storage tank (1.5 mg), Baldwin Park, Calif. (civil) $75,000. Client, County Water District.
¶ Evaluation of portion of distribution system, Escondido, Calif. (civil) Client, Escondido Mutual Water Co.
¶ Water distibution system for subdivision, Ridgecrest, Calif. (civil) $50,000. Client, Miracle City Subdivision Co.

Hugh B. Brewster
Fresno, California
¶ New city hall, complete plans and specifications for new building to house city offices, water department, and police department, Reedley, Calif. (struc., civil) $70,000. Client, City of Reedley, Calif.
¶ Preliminary plans for 16-lane bowling alley with bar and restaurant, Lemoore, Calif. (struc., civil) $140,000. Client, South Sea Lanes, Inc.
¶ Master plans for grounds improvement at Bullard, Powers, and Baird elementary schools; Erwin and Wawona junior high schools, Fresno, Calif. (civil) Client, Fresno City Unified School District.

CONNECTICUT

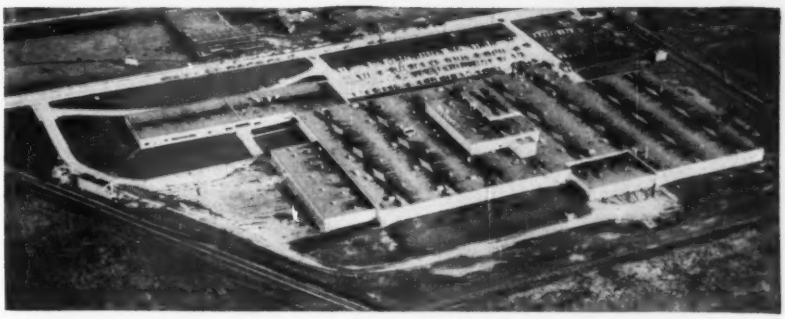
Van Zelm, Heywood & Shadford
West Hartford, Connecticut
¶ U.S. Atomic Energy Commission, six buildings, heating, ventilating, plumbing,

4-million bd. ft. of FOAMGLAS® insulation gives Kraft Foods, Ltd. permanent insulation value . . .

4 inches of FOAMGLAS insulate the roof area. Since this insulation is a natural vapor barrier, it prevents moisture migration into the plant below.

Vermin can't get through the inorganic glass cells of FOAMGLAS, which forms a complete insulation envelope — walls, floor and ceiling—around the Kraft products shown here.

Kraft's Montreal plant will produce a wide range of food products, including cheese, salad dressing products, caramels, marshmallows, candies and jellies.



plus free-standing partition walls . . . plus vapor-proof walls, ceilings and roof . . . plus vermin-proof storage . . . plus load-bearing insulated floors

Kraft Foods, Limited, picked FOAMGLAS, the cellular glass insulation, to provide important extra benefits for their new Montreal cheese plant. The sealed glass cell structure of FOAMGLAS insures unvarying insulating efficiency—because it makes the insulation moisture-proof. And, it does a lot more.

For one thing, it makes FOAMGLAS one of the strongest insulations. It permitted Kraft to erect free-standing walls of insulation . . . for easy, economical subdivision of storage spaces. And because FOAMGLAS is so strong, Kraft put it under concrete wearing floors where it easily stands up under both live and static loads.

Another thing: since FOAMGLAS is fully rigid and dimensionally stable, it proved a perfect choice for use in suspended ceilings in the Kraft plant.

And since FOAMGLAS is a natural vapor barrier, it's completely effective in preventing moisture migration into the cheese storage areas. That's a big help in keeping mold from forming on the cheese.

In addition to FOAMGLAS insulation, Pittsburgh Corning also makes available wall finishes and joint sealing compounds necessary for a complete installation. Write for our latest low temperature insulation literature. Pittsburgh Corning Corporation, Dept. R-129, One Gateway Center, Pittsburgh 22, Pa. In Canada: 3333 Cavendish Blvd., Montreal, Que.

PITTSBURGH PC CORNING

electrical. (mech., elec.) $300,000. Client, Rutherford, architect.
¶ Veterans hospital, Newington, Conn., boilers. (mech., elec.) $125,000. Client, Federal government.
¶ Wesylan University, Middletown, Conn., boilers and electrical. (mech., elec.) $200,000. Client, Weslyan Univ.
¶ McCook Hospital, Hartford, Conn., boilers. (mech., elec.) $150,000. Client, City of Hartford, Conn.
¶ Hartford Hospital, cooling and renovations. (mech., elec.) $200,000. Client, owners.
¶ Hamilton Standard, Broad Brook, Conn., air conditioning. (mech., elec.) $100,000. Client, owners.
¶ Slade senior high school, New Britain, Conn. (mech., elec.) $1.6 million. Client, Wilkins, architect.
¶ Pulaski senior high school, New Britain, Conn. (mech., elec.) $1.6 million. Client, Wilkins, architect.
¶ Connecticut State Library, heating, plumbing, electrical, air conditioning. (mech., elec.) $1 million. Client, Jeter & Cook, architects.
¶ Portland high school, Portland, Conn., heating, plumbing, electrical. (mech., elec.) $1.5 million. Client, Malmfeldt, architect.
¶ Glastonbury town hall, heating, plumbing, electrical, air conditioning. (mech., elec.) $400,000. Client, Jeter & Cook, architects.
¶ Taft school, dining hall, science building, steam plant, heating, plumbing, electrical. (mech., elec.) $1 million. Client, Jeter & Cook, architects.

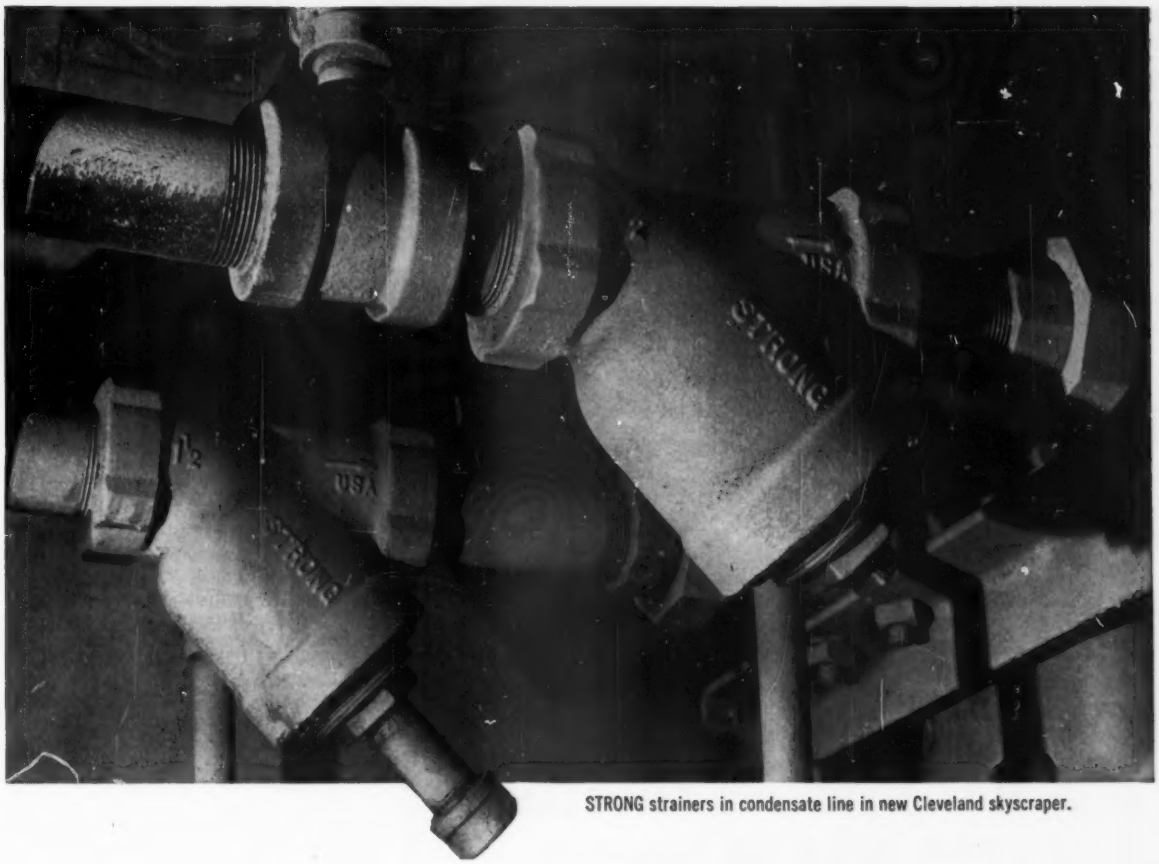
A. J. Macchi, Engineers
Hartford, Connecticut
¶ Enfield high school, Enfield, Conn. (struc.) $3 million. Client, Olson & Miler.
¶ Labor building, Public Works Department, Hartford, Conn. (struc.) $2 million. Client, State of Connecticut.
¶ Middletown State Hospital warehouse, Middletown, Conn. (struc.) $300,000. Client, Pedersen & Tilney, architect.
¶ Restaurant and store, Sharon, Conn. (struc.) $30,000. Client, W. D. Brown.
¶ Aetna Life cafeteria addition, Hartford, Conn. (struc.) $3 million. Client, Ebbets, Frid & Prentice, architects.
¶ Law school, Hartford, Conn. (struc.) $1 million. Client, F. Teich, arch.

DELAWARE

Kain and Hooven
Lansdowne, Pennsylvania
¶ Presidential Motel, three stories, 56 units, located at Wilmington, Delaware. (struc., civil) $300,000. Client, A. Gray, Magness builder.
¶ Midway shopping center, New Castle, County, Delaware. (struc.) $1.5 million (est.) Client, A. Gray Magness, builder.

FLORIDA

Oboler & Clarke
Miami Beach, Florida
¶ Educational building, four stories, reinforced concrete, First Baptist Church,



STRONG strainers in condensate line in new Cleveland skyscraper.

select the STRONG® strainer *designed for you!*

IN steam, air, gas, water, oil or chemical systems, a *correctly selected* strainer pays for itself many times. It protects expensive equipment (traps, control instruments, meters, etc.) and reduces over-all maintenance and service costs.

Assure your system maximum protection from dirt, scale, sludge and sediment . . . specify *the* STRONG strainer designed for your requirements.

Sizes: from ¼" to 8"

Service: 250 psi at 450° F to 2500 psi at 1100° F

Screens: stainless screens with .027", .045", .062", or .125" perforations (at no extra cost)

Types: "Y" or Angle with screwed or socket-weld (flanged) connections

Materials: semi-steel, ductile-iron, bronze, Monel, cast or block steel, or new all-stainless or Hasteloy

STRONG'S extensive line of rugged, high-quality strainers are available from your local STRONG distributor. Contact him for assistance in selecting the *right* strainer, or write for your copy of STRONG Bulletin SS—21C.

STRONG, CARLISLE & HAMMOND

508 Sandusky Street, Conneaut, Ohio

air traps • strainers • reducing valves • vacuum or pumping traps
continuous blowdown valves • separators • engine stops • F and T traps • safety headgear

Daytona Beach, Fla. (struc.) Client, Francis Walton, architect.
¶ Union building, three stories, reinforced concrete, Daytona Beach, Fla. (struc.) Client, Francis Walton, architect.
¶ Vehicle inspection station, Town of Surfside, Fla. (struc., mech., elec.) $12,000 (est.) Client, Town of Surfside.
¶ Planetarium and museum, reinforced concrete spread footings, gunite planetarium dome, Metropolitan Dade County. (struc.) $500,000. Client, Pan-coast, Ferendino, Skeels & Burnham, Arch.

Shelby Sanders & Associates, Inc.
Pensacola, Florida
¶ Sewage treatment plant and sewer lines. (struc., civil, mech., elec.) $340,000. Client, City of Bonifay, Florida.

ILLINOIS

Jenkins, Merchant and Nankivil
Springfield, Illinois
¶ Rehabilitation of electrical system, Illinois State Fair Grounds. (struc., civil, mech., elec.) $250,000. Client, State of Illinois, Department of Agriculture.
¶ Highway, Interstate 70, Project I-70-2, Madison County, Illinois. (struc., civil) $3,250,000. Client, State of Illinois, Division of Highways.
¶ Cook Street Sewer District, Springfield, Ill. (civil) $990,000. Client, City of Springfield, Illinois.

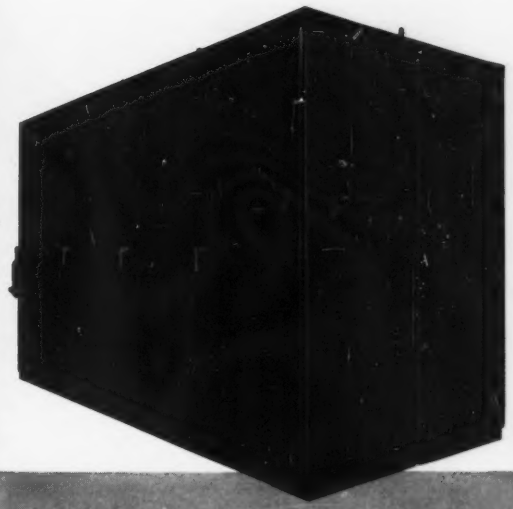
R. J. Abramson & J. M. Klipp
Chicago, Illinois
¶ Briarwood Country Club, Des Plaines, Ill. (mech., elec.) $700,000. Client, Barancik, Conte & Associates.
¶ Drewry's Ltd., Chicago, Ill. (mech., elec.) $300,000. Client, Lundstrum & Skubic.
¶ Interstate Steel Co., Des Plaines, Ill. (mech., elec.) $200,000 Client, Barancik, Conte & Associates.
¶ Shopping center, Oaklawn, Ill. (mech., elec.) $75,000. Client, Sidney H. Morris & Associates.

J. L. Adams
Denver, Colorado
¶ Site survey. (civil) Client, Perkins & Will, Chicago, Ill.

Allen-Munger & Associates
Grayslake, Illinois
¶ Sanitary sewer extension to Mundelein, Illinois sewage disposal system. (civil) $120,000. Client, Developer.
¶ Sanitary sewer extension for North Shore Sanitary District for Park City, Ill. (civil) $100,000. Client, City Council.
¶ Pavement widening for Round Lake Beach, Ill. (civil) $30,000. Client, Village Board.
¶ Subdivision development, Mundelein, Ill. (civil) $95,000. Client, Developer.

Consulting Associates
Chicago, Illinois
¶ Golf Mill shopping center, Niles, Ill. 335,000 sq ft sales area, approximately 40 stores in six separate buildings, all air conditioned. (mech., elec.) $4 mil-

for high voltage service continuity on your critical loads at lower capital outlay— it's S&C Metalclad Switchgear!

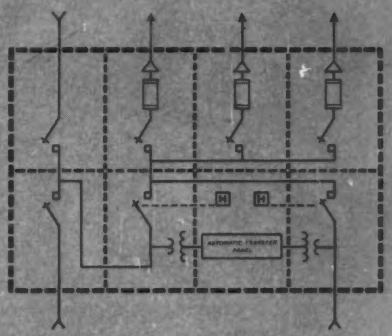


To get service continuity on critical loads, you need preferred-to-emergency switching of your alternate incoming high-voltage supply circuits, and short-circuit protection and switching on your outgoing high-voltage supply feeders. All of this can be provided in one low-cost package in S&C Metalclad Switchgear, as illustrated.

You even have built-in choices of throwover schemes through S&C's standard automatic transfer panels.

You save two ways:

1. You get metalclad switchgear with job-matched load interrupters and power fuses, in lieu of costly circuit breakers.
2. You eliminate cost of custom designing by using an off-the-shelf transfer panel with built-in options.

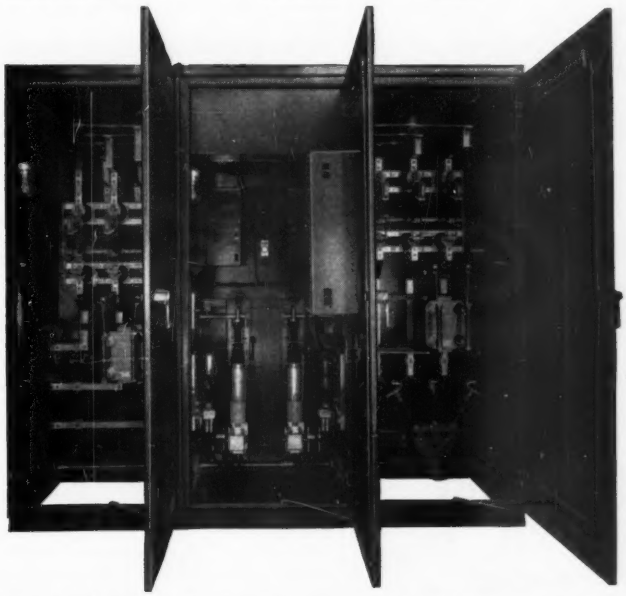


Schematic for 8-bay switching center unit (above) shows throwover control of 2 of 3 alternative incoming sources to provide continuous service for three outgoing feeders.

No organic insulation to cause corona trouble; porcelain and air only.

High-Speed Automatic Switching.

Full-length bulkhead doors; rainproof, with complete access.



Super Durabake finish with galvanized and stainless steel hardware; withstands corrosive atmospheres.

Separate compartment for Moto-Draulic operators; free access and decoupling for checkout.

Strip heaters with adequate venting prevents moisture accumulation.

S&C Standard Automatic Transfer Panel provides for making either source preferred, for automatic or manual return, for adjustable time delays, for choice of returning in either open or closed transition, and for optional lockout on bus faults.

Power Fuses
Tool Operated Disconnects
Open and Enclosed Cutouts
Fuse Links
"Loadbuster"
Load Interrupters
Metalclad Switchgear

S&C ELECTRIC COMPANY
4436 Ravenswood Ave. Chicago 40, Ill.

In Canada: S&C Electric Canada, Ltd.
8 Vansco Road, Toronto 14, Ontario

lion. Client, Walter W. DeCherrie & Associates, principal architects and Fisher & Shaffer, associate architects.
¶ International Motor Hotel, 146 guest rooms, public spaces including seven meeting rooms, restaurant and bar, complete kitchen facilities, all site improvements, Schiller Park, Ill. (mech., elec.) $1.2 million. Client, Fisher & Shaffer, architects.
¶ Sanctuary and school building for Beth Torah Congregation. (mech.) $150,000. Client, Albert R. Belrose, architect.

Richard J. Rasmussen
Elmhurst, Illinois
¶ Sturdy, expansion of Scoville Park Hotel, Oak Park, Ill. (struc., civil, mech., elec.) $500,000. Client, Hotel.
¶ New building code for Villa Park, Ill. (struc., civil, mech., elec.) Client, Village of Villa Park.

Bradford Saivetz & Associates, Inc.
Quincy, Massachusetts
¶ Weathersfield, Schaumberg, Ill., 2000-unit single family housing. (review engineering work) $38 million. Client Campanelli Bros. of Illinois, Inc.

INDIANA

Robert L. Longardner & Associates
Indianapolis, Indiana
¶ Factory renovations, John Sexton & Co., Indianapolis, Ind. (struc., civil, mech., elec.) $460,000.
¶ Confidential project for Northern Indiana Public Service Co. (civil)
¶ Several bridges, Indianapolis Board of Public Works, Indianapolis, Ind. (struc., civil) $400,000.

IOWA

Bartels & McMahon Engineering Co.
Dubuque, Iowa
¶ 72-in. diameter storm sewers, Dubuque, Iowa. (civil) $38,000. Client, Board of Dock Commissioners.

Frank L. Pulley, Consulting Engineer
Des Moines, Iowa
¶ Men's dormitory, Morningside College, Sioux City, Iowa. (mech., elec.) $400,000 (est.) Client, Wm. Beuttler & Son.
¶ Craig Wright school, Des Moines, Iowa. (mech., elec.) $500,000. Client, Dougher-Frevert-Ramsey, architects.
¶ Webster City high school, Webster City, Iowa. (mech., elec.) $900,000. Client, Savage & VerPloeg, architects.
¶ Classroom building, Iowa State University, Ames, Iowa. Completely air conditioned, using absorption water chilling machine with dual duct high velocity air distribution system, each classroom equipped with TV receiver for closed circuit TV (mech., elec.) $1.3 million. Client, Wetherell and Harrison, Des Moines, Iowa.
¶ Physiological Instrumentation Research Laboratory, Iowa State University, Ames, Iowa. Completely air conditioned utilizing absorption water chilling machine and dual duct high velocity air distribu-

tion system. (mech., elec.) $500,000. Client, Dougher, Frevert, Ramsey, arch.

KANSAS

Anton Hanson
Jamestown, Kansas
¶ Nine blocks curb and gutter and 4-in. base paving. (civil) $38,870. Client, City of Courtland, Kansas.

Richardson Electrical Engineering Company
Solomon, Kansas
¶ New telephone system for eight towns (1900 subscribers), six new telephone exchanges with 600 miles of new outside telephone plant. (struc., mech., elec.) $1,260,000. Client, Blue Valley Telephone Co., Marysville, Kansas.

Burgwin & Martin
Topeka, Kansas
¶ Plans and specifications for approximately 500 feet of influent line to sewage treatment plant. Cast iron pipe on timber piling. (civil) $16,000 (est.) Client, City of Enterprise, Kansas.
¶ Report on sewer system and sewage treatment plant. (civil) $200,000 (est.) Client, City of Highland, Kansas.
¶ Plans for bridge and approaches over Willow Creek, Greenwood County, Kansas. (struc., civil) $60,000 (est.) Client, County of Greenwood, Kansas.
¶ Plans and specifications for repair of asphalt roads and parking lots at Naval Air Station, Olathe, Kansas. (struc., civil) $110,000 (est.) Client, U.S. Navy.
¶ Plans and specifications for county secondary road, primarily for access to missile site. (struc., civil) $6000 (est.) Client, County of Jefferson, Kansas.
¶ Plans and specifications for 400-ft bridge over Marais des Cygnes River, Franklin County, Kansas. (struc., civil) $150,000. Client, Franklin County, Kansas.
¶ Plans and specifications for 400-ft bridge over Shoal Creek, Cherokee County, Kansas. (struc., civil) $150,000. Client, Cherokee County, Kansas.
¶ Structural design, Wilson County courthouse, Fredonia, Kansas. (struc.) $500,000. Client, Kiene & Bradley, arch.
¶ Plans and specifications, reinforced concrete box girder bridge over interstate Topeka bypass, Shawnee County, Kansas. (struc., civil) $75,000. Client, State of Kansas.
¶ Structural design, Chanute, Kansas Building & Loan. (struc.) $100,000. Client, Kiene & Bradley, architects.

KENTUCKY

Napier Engineering Company
Louisville, Kentucky
¶ Woodland Terrace subdivision, Louisville, Ky. (civil) $50,000. Client, Joe S. Doyle.
¶ R.C.P. Thomas Estates subdivision, Bowling Green, Ky. (civil) $75,000. Client, Ogden Estate.
¶ Middletown Manor Swim Club, Middletown, Ky. (civil) $60,000. Client, Middletown Manor Swim Club, owner.

MARYLAND

Buchart Engineering Corporation
York, Pennsylvania
¶ Centre Methodist Church, Forest Hill, Maryland. (struc.) $60,000. Client, Trustees, Centre Methodist Church.

MASSACHUSETTS

Bradford Saivetz & Associates, Inc.
Quincy, Massachusetts
¶ Bishop Gardens, Framingham, Mass., 220-unit apartment development. (civil) $3.3 million. Client, R.&S. Constr. Co.
¶ Woodvale, Danvers, Mass., 531-unit single family housing. (civil) $10 million. Client, Campanelli Builders.
¶ Pleasantfield, Raynham, Mass., 330-unit single family housing. (civil) $5 million. Client, Braintree Homes, Inc.
¶ Nob Hill, Framingham, Mass., 190-unit single family housing. (civil) $4 million. Client, Pinewood Builders, Inc.
¶ Chelmsford Estates, Chelmsford, Mass., 175-unit single family housing. (civil) $3 million. Client, East Coast Builders.
¶ Westfield, Brockton, Mass., 146-unit single family housing. (civil) $2.5 million. Client, Braintree Homes, Inc.
¶ Crestfield, Brockton, Mass., 56-unit single family housing. (civil) $0.75 million. Client, Braintree Homes, Inc.
¶ Brookfield, Brockton, Mass., 700-unit single family housing. (civil) $12.5 million. Client, Braintree Homes, Inc.
¶ Courtfield, Brockton, Mass., 400-unit single family housing. (civil) $6.5 million. Client, Braintree Homes, Inc.

A. J. Macchi, Engineers
Hartford, Connecticut
¶ Strathmore paper warehouse, Springfield, Mass. (struc.) $250,000. Client, Ley Constructors, Springfield, Mass.

Bertram M. Hadfield
Framingham Center, Massachusetts
¶ Advice and assistance in specification, design, and manufacture of military and civilian electronic equipment. (elec.) Client, Advance Industries, Cambridge, Mass.
¶ Advice and assistance in specification, design, and use of telemetry instrumentation and data reduction. (elec.) Client, Avco Research & Advanced Development, Wilmington, Mass.

MICHIGAN

Smith, Hinchman & Grylls Associates
Detroit, Michigan
¶ Parke-Davis Company research and production center. (struc., civil, mech., elec.) $5 million. Client, Parke-Davis.
¶ Metropolitan Hosp. (struc., civil, mech., elec.) $3.5 million. Client, City of Detroit.
¶ Michigan Bell Tel. district offices. (struc., civil, mech., elec.) $2 million.

McNamee, Porter & Seeley
Ann Arbor, Michigan
¶ Relief drains located in cities of St. Clair Shores, Roseville, and East Detroit, Mich. 8½-mile road drain, pumping station, and holding basin ($8,685,-

NEW MULTI-ZONE PLATECOIL®

An exclusive* TRANTER advancement in heat transfer technology

*PATENTS APPLIED FOR

For new savings on more types of tank and process heating than ever before!

Now you can apply the time-proven cost and performance advantages of PLATECOIL over pipe coils to heating and cooling problems involving pressures up to 250 psi. DURAWELD construction, TRANSTEEL mild steel and MULTI-ZONE coil configuration are brand new design and construction features that provide for higher pressure containment and a margin of heat transfer capacity.

MULTI-ZONE coil configuration with multiple headers produces a reserve capacity for faster start-up and better temperature maintenance. High heat transfer efficiency saves tank space. Light weight makes installation easy and economical. Streamlined surfaces are easy to clean. Eliminate the cost of engineering, fabricating and installing pipe coils. Specify the new MULTI-ZONE PLATECOIL.

Standard PLATECOIL units

FACTORY-ASSEMBLED PLATECOIL banks.

In factory-fabricated styles to fit your needs

ROLLED to specified diameters

SINGLE EMBOSSED OR DOUBLE EMBOSSED

SEND FOR NEW PLATECOIL BULLETIN P85 for complete data and performance characteristics.

Tranter Manufacturing Inc.

LANSING 9, MICHIGAN

PLATECOIL® DIVISION

000); Stephens drain ($4,110,000); 11½-mile road drain ($5,356,000); Lake Boulevard drain ($1,747,000). Planning of certain portions of the project have been sublet to Harry J. Fuller, Mt. Clemens ($4,043,000) and Lehner Associates, Inc., Mt. Clemens ($2,627,000). Client, Macomb Co. Drain Commission.

Giffels and Rossetti
Detroit, Michigan
¶ Hospital, 350-bed, nurses' home, laundry, Southfield, Mich. (struc., civil, mech., elec.) $8 million. Client, Providence Hospital, Detroit.
¶ Complete fiberboard mill, L'Anse, Mich. (struc., civil, mech., elec.) $12 million. Client, Celotex Corp.
¶ SAC facilities at eight bases. (struc., civil, mech., elec.) $15 million. Client, Corps of Engineers, Detroit, Mich.
¶ Engineering laboratory, East Lansing, Mich. (struc., civil, mech., elec.) $3 million. Client, Michigan State University.
¶ Detroit post office, over 1 million sq ft. (struc., civil, mech., elec.) $23 million. Client, U.S. Post Office Department.

MINNESOTA

Jos. V. Edeskuty & Associates
Minneapolis, Minnesota
¶ 5320-kw single shaft simple cycle gas turbine for combined cycle in steam plant, for municipal power plant, Austin, Minn. (struc., civil, mech., elec.) $960,-000 (est.) Client, Board of Water, Electric, Gas & Power Commissioners, Austin.

MISSOURI

Edward W. Bilhorn
St. Louis, Missouri
¶ Reconstruction of Robyn Road, plus storm sewer and maintenance of roadways. (civil, mech.) $60,000. Client, City of Sunset Hills, Missouri.

Butler & Associates
Columbia, Missouri
¶ National Guard Armory, Lexington, Mo. 14,500 sq ft, thin shell concrete, folded plate roof over drill hall, remaining roof system, 8-in. thick precast concrete slab panel. (struc., civil, mech., elec.) $169,-512. Client, National Guard Bureau.
¶ National Guard Armory, Fulton, Mo. 14,940 sq ft, thin shell concrete, folded plate roof over drill hall, remaining roof system, 8-in. thick pre-cast concrete slab panels. (struc., civil, mech., elec.) $172,-161. Client, National Guard Bureau.

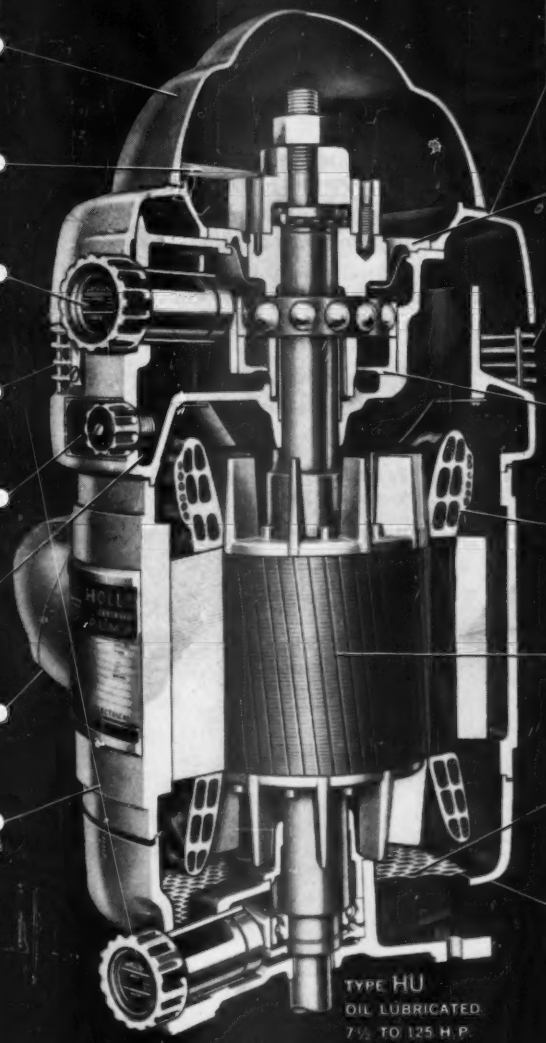
NEW MEXICO

J. L. Breese & Associates
Santa Fe, New Mexico
¶ Congregate Home. Living and dining facilities for retired Presbyterian ministers, Santa Fe, New Mexico. (mech.) $500,000 (est.) Client, Clark & Register.

Tippett and Gee
Abilene, Texas
¶ 16,500-kw steam power station addition. (struc., civil, mech., elec.) $3.5

Unveiling... U.S. HOLLOSHAFT MOTORS

YEARS AHEAD FOR YEARS TO COME!



TOP COVER
is lightweight, easily removed

UNIQUE LOCK BAR
holds shaft during adjustment

LUBRISCOPE
combined gauge and rapid oil fill

PROTECTIVE GRILLE
prevents entrance of leaves, papers, etc.

OIL CHANGE RECORD
dial indicates date of last oil change

SEDIMENT SUMP
collects grit particles for easy drain

SPLIT TYPE OUTLET BOX
provides easy motor connection

NORMALIZED CASTINGS
maintain accuracy of machining

TOP COWL
motor remains protected during adjustment

BEARING COVER
protects bearing during pump adjustment

LARGE AIR OPENING
reduces intake velocity

PROVISION FOR STACKED BEARINGS
extra heavy thrust easily obtained

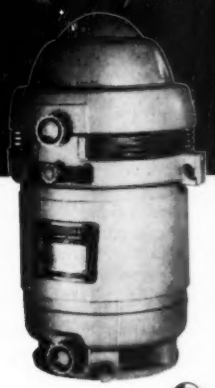
ASBESTOS-PROTECTED WINDINGS
non-carbonizing asbestos extends life

SOLID CAST ALUMINUM ROTOR
with integral fan, provides indestructible structure

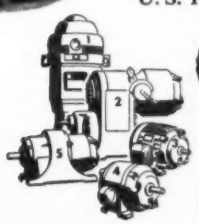
RODENT GUARD
prevents damage due to entry of small animals

IMPROVED WINDING PROTECTION
meets NEMA Weather-Protected Type I requirements

TYPE HU
OIL LUBRICATED
7½ TO 125 H.P.



All new! In Holloshaft Pump Motors, U. S. engineers introduce a new relationship between form and function, as well as many U. S. originated benefit features skillfully translating wishes and suggestions of pump users into practical motor construction. Rugged Holloshaft offers weather protection exceeding NEMA Type I requirements—*plus* enduring, distinctive styling to harmonize with modern pump design. For years-ahead satisfaction, specify: "U. S. HOLLOSHAFT MOTORS."



U.S. ELECTRICAL MOTORS INC.

P. O. BOX 2059, LOS ANGELES 54, CALIFORNIA
OR MILFORD, CONNECTICUT

U.S. MAJOR MOTOR LINES INCLUDE:
1. Vertical Solid & Holloshaft, 2. Varidrive, 3. Totally-Enclosed, 4. Uniclosed, 5. Syncrogear. Also, many other special motors.

FREE COLOR BROCHURE
... for full information, send for FREE Holloshaft Bulletin, No. F-1953.

million. Client, Lea County Electric Cooperative, Lovington, New Mexico.

NEW YORK

James N. De Serio, P.E.
Buffalo, New York
¶ Ten-story dormitory building, University of Buffalo, Buffalo, N.Y. (struc.) $3.5 million. Client, James, Meadows and Howard, Architects.

NORTH DAKOTA

Foss & Company
Moorhead, Minn. & Fargo, N.D.
¶ Sanitary sewerage system and sewage disposal lagoon. (struc., civil, mech., elec.) $100,000 (est.) Client, City Council, Wyndmere, N.D.

OHIO

Giffels and Rossetti
Detroit, Michigan
¶ Salt plant and mine shaft, Cleveland, Ohio (struc., civil, mech., elec.) $10 million. Client, International Salt Co.

Eugene Herzog & Associates
Dayton, Ohio
¶ Stable gaseous isotope separation facility, Miamisburg, Ohio. (struc., civil, mech., elec.) $100,000. Client, Atomic Energy Commission.

William Schuller
Toledo, Ohio
¶ Nine-classroom addition to School for Sacred Heart of Jesus, Fremont, Ohio. (struc.) $114,000. Client, Schander & Martin, architects.
¶ Addition to St. Paul's Lutheran Church, Maumee, Ohio. (struc.) $213,400. Client, Hahn & Hayes, architects.
¶ Somerset Inn motel, Shaker Heights, Ohio. (struc.) $1.3 million. Client, H. F. Feldstein, architect.

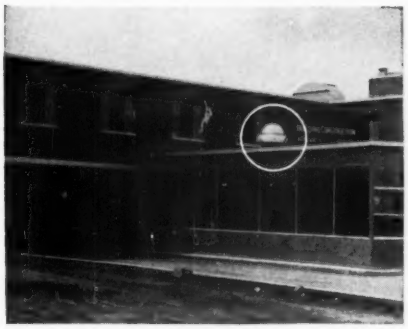
Charles L. Barber & Associates
Toledo, Ohio
¶ Interstate relocation of U.S. Route 23, 12.2 miles. (struc., civil, mech., elec.) $12 million (est.) Client, Ohio State Highway Department.

W. I. Barrows & Associates
Dayton, Ohio
¶ 20,000 kw addition to municipal power plant at Piqua, Ohio. 875 psig, 915 F, 215,000 pounds per hour steam generator, hydrogen cooled turbine generator, four stages feedwater heating, demineralized makeup. Plant arranged to fire Ohio strip mine coal on traveling grate stoker. (struc., civil, mech.) $4,750,000. Client, City of Piqua.

Verne M. Clarke Engineering Company
Cleveland, Ohio
¶ Maplecrest-South Park trunk sanitary sewer, Cuyahoga County, Ohio Improvement No. 230 in the Village of Brooklyn Heights, Ohio (struc., civil) $654,883.50. Client, Board of County Commissioners of Cuyahoga County, Ohio. ▲▲

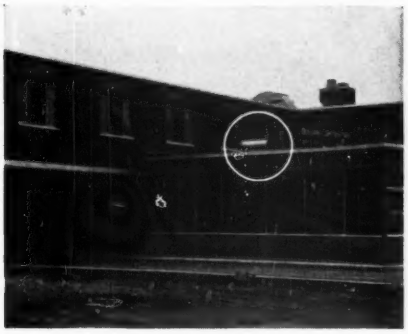
It's what you can't see that's important!

PENN VENTILATOR'S TRULY LOW-CONTOUR DYNAFAN



BEFORE

These before and after job photographs illustrate how Penn's LC Dynafan reduces roof exhauster heights and protects your job appearance.



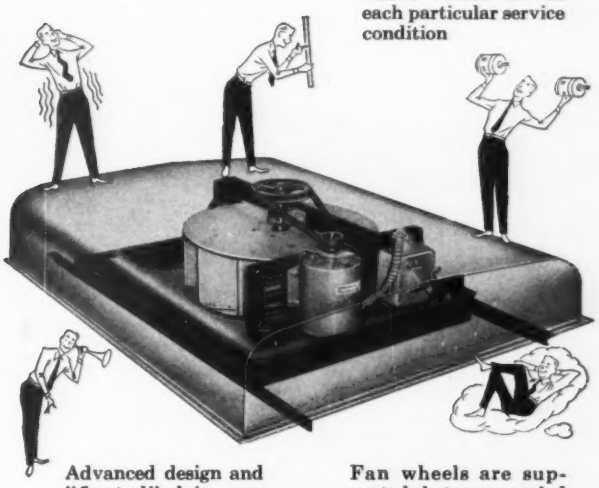
AFTER

On this job competitive units were installed and replaced by LC Dynafans. Protect your finished job appearance at the time of design—Specify LC Dynafans.

Gives greater stability, better balance, eliminates vibration

Cuts 50% off normal roof exhauster heights

Exact motor to fit each particular service condition



Advanced design and "floated" drive assembly appreciably cuts noise

Fan wheels are supported between sealed ball bearings—maintenance is minimized

The highest quality and unobtrusive appearance are yours when you use the Low-Contour Dynafan. Identical housing designs are available for both supply and relief units, also. The Penn Ventilator man in your area can give you complete details. Call him . . . today.

A Leading Manufacturer of Powered and Gravity Roof Exhausters and Accessory Equipment for over 25 years.

PENN VENTILATOR CO., INC.
GOODMAN & ALLEGHENY, Philadelphia 40, Pa.
Representatives and Distributors in Principal Cities
Charter member of AMCA

Steel bridge carrying US Route 22 over Bushkill Creek in the vicinity of Easton, Penna.

John R. Dietz, Vice President, Earl D. Schwartz, Chief of Bridge Section, and W. H. Corddry, President, discussing an artist's rendering of a steel bridge over the Southwest Freeway in the District of Columbia.

Steel enjoys wide use in short-span bridge design

at Gannett, Fleming, Corddry & Carpenter, Inc., Consulting Engineers, Harrisburg, Penna.

This firm has designed short-span steel bridges for many important highways. These include the Pennsylvania, New Jersey and West Virginia Turnpikes; the Connecticut Expressway; Garden State Parkway; Penn-Lincoln Parkway, Pittsburgh; Schuylkill Expressway, Philadelphia; and Southwest Freeway, Washington, D. C.

Normally, 70% of their short-span bridges are designed in steel. There are many good reasons for this, according to Mr. John R. Dietz, Vice President in charge of the highway and bridge division of the firm.

Steel is a familiar material. There is a tremendous library of knowledge accumulated on steel and there are no unknown factors. This is important because the designer is looking for reliable performance.

Steel goes up in a hurry. Short spans must be constructed with least interference with traffic. The rapidity with which steel can be erected is a big advantage.

Steel permits maximum headroom. Also minimum approach alteration, less dislocation of existing buildings and roads and lower costs.

Steel reduces costs. Lighter construction with steel reduces foundation costs and faster erection saves labor. New high-strength steels offer greater strength with less bulk.

Steel production facilities have increased. The steel industry has greatly expanded its facilities for manufacture of structural shapes and plates. You can confidently design in steel—the material you know best, and the material that offers you the most.

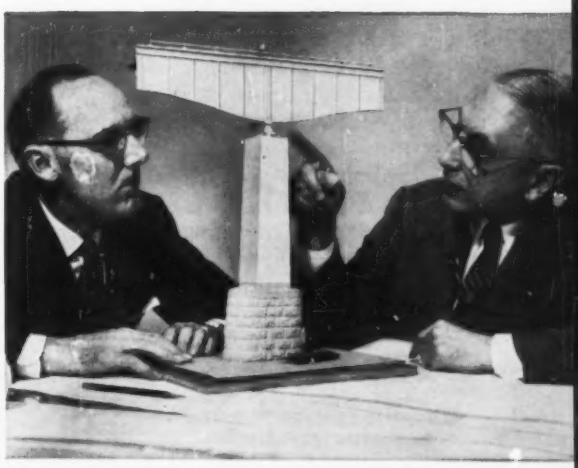
USS is a registered trademark

USS

United States Steel Corporation—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

United States Steel

Steel bridge carrying Route 22 over Route 309 near Allentown, Penna. Steel is versatile and available. It can be readily welded, flame-cut, riveted, bolted.



Mr. Dietz (left) and Mr. Schwartz discussing a model of a welded steel girder on an elevated pier.

Books

Parallel Reading for Consulting Engineers

It took seven months of wartime emergency work, with as many as 8000 men on the job at one time, to clean up after the Great Bombay Explosion of April 14, 1944. Yet, scarcely a word was said about this disaster in the press, for there was a thick security blanket over all the news. This Bombay explosion was probably one of the greatest non-nuclear explosions in history. About 34,640 tons of shipping were lost to the allied cause, 10 of the 25 ships in the Victoria Dock being wrecked so completely that they were simply sold for scrap. It is estimated that there were 1376 casualties, of which a known 233 were killed. The true figures were undoubtedly much higher than this.

What happened involved the SS *Fort Stikine*, a British ship built in Canada, and handed over to the British under lend lease. She was a single screw, coal burning vessel of 7142 tons gross, one of 26 identical cargo ships built to a standard design. On February 24, 1944, the *Fort Stikine* sailed from England, around Gibralter, and to the Suez Canal as part of a convoy. She was carrying a dangerous cargo of explosives, 1318 tons including shells, torpedoes, mines, and incendiary bombs. On top of that (quite literally) was a steel tank, welded closed, containing £ 1 million (at that time worth almost $5 million) in gold bars.

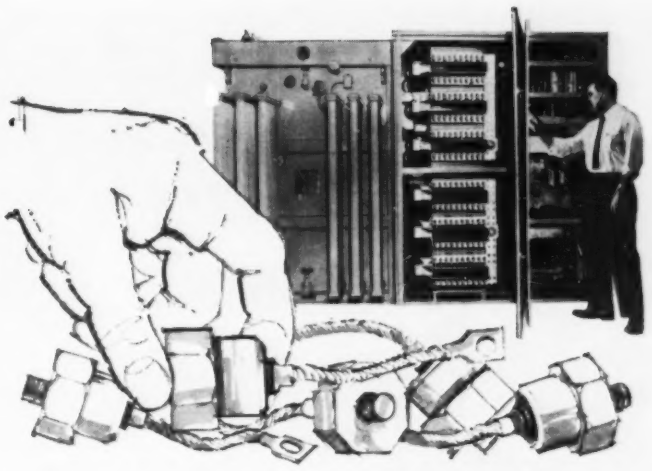
After sailing through the Red Sea and leaving the convoy, the *Fort Stikine* went to Karachi, where she unloaded a portion of her cargo, principally aircraft and other relatively innocent equipment. This was replaced with bales of cotton and drums of oil, some of which were leaky. A more dangerous cargo could scarcely have been loaded, and in this condition the *Fort Stikine* left Karachi and sailed for Bombay, where she arrived on April 12.

It was two days later, after a series of mishaps, miscalculations, and mischance, that she blew up, not once but twice. The *Fort Stikine* was berthed in Victoria Dock surrounded by 24 other vessels. After the second blow-up, every one of these vessels was damaged to some extent and most were completely destroyed. The *Jalapadema*, the ship berthed next to the *Fort Stikine*, was blown up into the air, coming down with one end on top of a 50-ft high warehouse beside the docks.

Flaming drums of oil and great ragged sheets of steel flew all over an area a mile in radius. Fires raged for days, and the hospitals were overcrowded for months.

The full explanation of this explosion is a fascinating one, and it is excellently told by John Ennis, a British newspaper man. Ennis writes professionally and tells a good story, but he has stretched this one out a bit more than it deserved. In his acknowledgements, he thanks, among others, a Mr. Eric Wright, who once said to him, "It will make a book." Perhaps, therefore, we should blame Mr. Wright rather than Ennis when we

EFFICIENCY IN A SEMICONDUCTOR RECTIFIER



The I-T-E UNITRON Semiconductor Rectifier

Today, in the electrochemical industry, the economy of the semiconductor rectifier as a source of d-c is scarcely disputed. Certain differences in efficiency, however, can produce significant differences in the ultimate economy which the user may enjoy. For example, the I-T-E UNITRON semiconductor rectifier incorporates unique design details which aim specifically to boost efficiency.

Voltage equalization—Variations in inverse resistance of semiconductor cells are normal. When cells are used in series, some method of inverse voltage equalization is required to prevent overworking of certain cells. Many seemingly obvious methods, such as using resistors or connecting complete rectifiers in series, etc., are uneconomical as regards both operating cost and space. For the UNITRON, I-T-E engineered a special circuit in which a small auxiliary transformer is used to maintain an equal inverse-voltage on all series cells without taking current from the system. This transformer, in fact, consumes no power. It needs no maintenance. And it makes possible the instant detection of cell failures for timely replacement before an entire series of cells fails.

Current equalization—Parallel connected cells will normally divide the total forward current unequally because of differences in forward resistance. Therefore cells with the lowest forward drop will carry a disproportionately higher share of the total current. But the UNITRON's unique current equalizer insures that all parallel cells will carry equal current, regardless of normal variations in forward resistance. The design is of the utmost simplicity, consisting entirely of iron laminations through which conductors from the parallel cells pass. There is nothing to fail or need service during the life of the rectifier. The action of this compact current equalizer materially extends cell life and keeps cell maintenance cost and downtime to a minimum.

Random cell selection—The combination of forced voltage equalization for series cells and forced current equalization for parallel cells gives the I-T-E UNITRON virtual freedom from the effects of normal variations in cell resistance. Users may select cells at random for any position. This eliminates the nuisance—and the expense—of coding cells for various positions. Yet at the same time you have greater assurance of long cell life, because the overloading of individual cells is eliminated.

Water cooling—Just in the cooling system alone, the I-T-E UNITRON saves money over other rectifiers. First, it costs so little to operate. Second, it takes little space. Third, it prolongs average cell life. It uses ordinary tap water . . . no coolant is more efficient than water or costs less. A purification system continually removes contaminants and free ions to protect the system from corrosion and prevent electrical leakage. Since it is a closed loop system, it cools each cell to the same temperature . . . eliminating hot cells and premature failures. And it permits the changing of cells without disturbing the cooling system. This unique I-T-E UNITRON cooling system eliminates the need for power-eating blowers and space-eating ducts. Also it saves the cost of special coolants and spares personnel from the risk of skin irritation.

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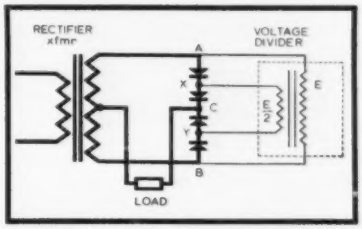
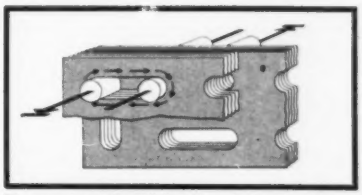
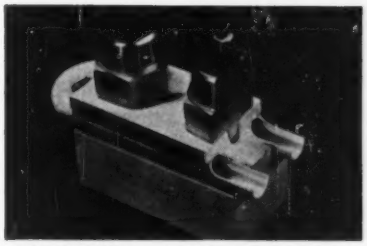


Simplified schematic of voltage equalizer. When side A is conducting, voltage between C and B is equal to that between A and B (neglecting the small drop through the cells). The voltage divider secondary applies a voltage between C and Y which is half that between C and B. This divides the inverse voltage between the two non-conducting cells evenly.



The current equalizer. Adjacent conductors carrying current in opposite directions pass through overlapping windows in two sections of iron laminations. Transformer effect of laminations effectively equalizes currents between neighboring conductors.



Section of bus bar . . . showing how cooling water flows close to cells for efficient cooling. Bus bar can be as long as necessary to hold the number of required cells. No need to drain system to change cells.

I-T-E CIRCUIT BREAKER COMPANY

find that the material does not quite make a book.

As might be expected of a good newspaper man, Ennis writes best when describing actual occurrences and giving the story in a straightforward manner. He fails when he attempts to establish moods, particularly where he tries to build up interest by giving a full description of the whereabouts and thoughts of many unrelated characters just a few minutes before the explosion. This just is not his kind of writing.

Despite these faults, which come about almost entirely from trying to make 182 pages of story out of 120 pages of material, the book is well worth reading and is one no engineer could fail to enjoy.

We have just one other complaint. It seems that Bombay was practically overrun with army (U. S. Army) photographers at the time of the explosion, and it is hard to believe that the eight photographs published here are the best of their work. One or two are fairly good, but generally, they are disappointing.

•

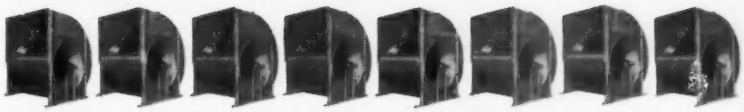
Book Reviewed in This Issue

The Great Bombay Explosion, by John Ennis; Duell, Sloan & Pearce, Inc., 19 W 40th St., N. Y.; $3.50.

•

New Technical Books

ALUMINUM CONSTRUCTION MANUAL, published by the Aluminum Association, New York, N.Y.; $3.00. As a relative newcomer in the structural metals arena, aluminum could not "wait out" a slow development of design data such as the evolutionary process which gave us today's reference manuals for the traditional structural metals. The development of aluminum alloys of high strength, and the ever-improving competitive position of aluminum, have emphasized the need for a good comprehensive



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volume of design data for the convenient use of designers, especially those in the structural field. As an important forward step, therefore, the industry has published the first edition of what will undoubtedly become the standard reference for the use of structural aluminum. The work was supervised by Dr. R. B. B. Moorman, head of the Civil Engineering Department of Brooklyn Polytechnic Institute where most of the required laboratory and computation work was done.

The Aluminum Association recognized that the production of a complete manual, including data for all usable aluminum alloys would take so much time that it would delay the broader use of aluminum which awaited the manual's publication. Therefore, it was determined that the first edition would be published as soon as the complete data for one of the most widely used alloys, 6061-T6, had been compiled. In addition, data on nine other alloys is presented in such detail as will meet most structural needs. Succeeding editions will contain additional material now in work.

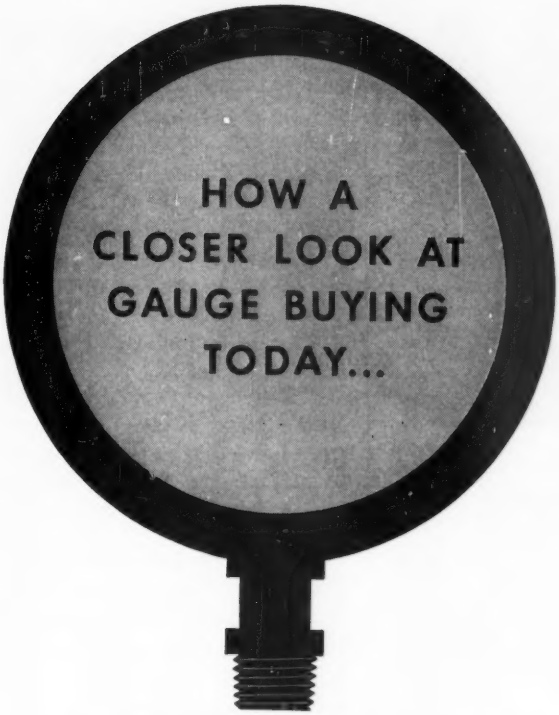
As this is, fundamentally, a reference work, contents are arranged for convenience into the five following parts:

¶Data most frequently needed by structural engineers and estimators engaged in designing aluminum structures after the forces to be resisted have been determined, i.e., elements of sections, standard tolerances, and miscellaneous design information.

¶ Dimensions, weights, and other data useful in preparing estimates and drawings that are not included in Part I of the manual.

¶Allowable Specifications (for Alloys 6061-T6 and 2014-T6), and data on mechanical and other properties of aluminum structural alloys, plus miscellaneous design information.

¶Miscellaneous data which might prove useful to the designer, most



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of which is not related, specifically, to aluminum.

Although the present scope of the manual is admittedly limited, its utility should not be underestimated. Meanwhile, use of the manual should serve to identify and develop changes (to increase its usefulness) which can be incorporated, in future editions.

For example, there might be a sharper separation of dimensioning data (for detailing) and design data. Some groupings of data (such as the tables dealing with tolerances on pages 40 to 73) might lend themselves to reorganization and condensation without loss of usefulness.

One area of information which deserves attention in forthcoming editions is that dealing with design for long-term sustained loads, such as data dealing with creep and shear lag. The dead loads common to building make such information important to the designer. Also, a section on welding would be a welcome addition.

Engineers look forward to the time when the present dimensional information on rivets and bolts will be supplemented with complete design data on high strength aluminum bolts with hardened washers, and with well drawn lines of demarcation to indicate the service area where the use of steel bolts would be advisable.

Another area that could be emphasized more is the standardization of finishes and of finish designations. With today's trend toward exposing structural members and actually using them for aesthetic effect, the designer's work would be simplified. And it must be added that the present lack of reasonable uniformity seems unnecessarily confusing.

In general, however, the manual is a valuable and sorely needed reference for the structural engineer. It should stimulate the use of aluminum in those areas of structural design where its properties are particularly adaptable. An

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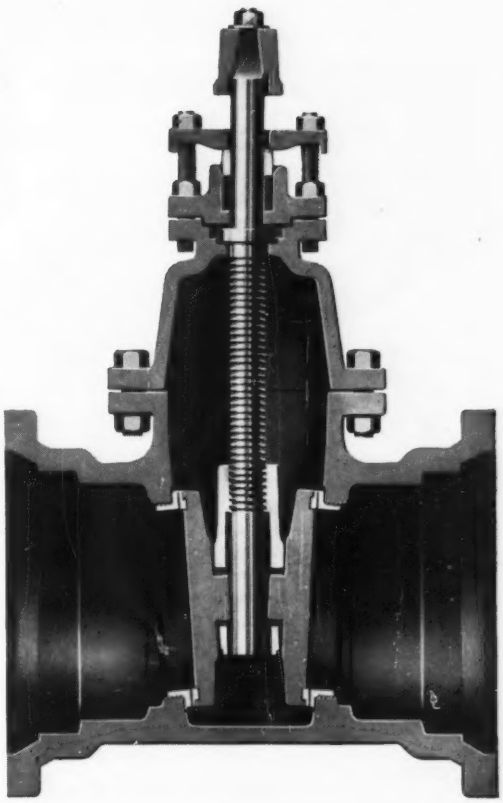

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excellent beginning has been made, and future editions should show steady improvement.

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ALGEBRAIC THEORIES, by Leonard E. Dickson, ($1.50); A TREATISE ON ALGEBRAIC PLANE CURVES, by Julian Lowell Coolidge, ($2.45); AN ELEMENTARY TREATISE ON FOURIER'S SERIES, by William Edward Byerly, ($1.75); and THE THEORY OF NUMBERS AND DIOPHANTINE ANALYSIS (one volume), by Robert Carmichael, ($1.35); Dover Publications, Inc., N. Y. These are four new titles in the publisher's well known series of mathematical reprints in paperback form. All are the work of American mathematicians writing in the "Golden Age" of American mathematical achievement around the turn of the century. There was produced at that time a body of mathematical literature which has since come to be highly regarded as one of our contributions to pure science. Dover Publications claim that over 20 percent of their sales of these "classics" are to overseas buyers.

NOMOGRAPHY, by Alexander S. Levens; John Wiley & Sons, Inc., N. Y.; $8.50. A nomogram is a graphic or pictorial presentation of a problem and its solution. Among the many fields to which this convenient tool may be applied are: electronics, statistics, ballistics, radioactivity, structures, heat transfer . . . in fact almost every area where consultants concern themselves.

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Consulting Engineers' Calendar

Nov. 29-Dec. 4. American Society of Mechanical Engineers; Annual Meeting, Chalfonte Haddon Hall, Atlantic City, New Jersey.

Dec. 1-4. National Warm Air Heating and Air Conditioning Association; Committee Meetings and Annual Convention, Chase Hotel, St. Louis, Mo.

Dec. 2. American Institute of Consulting Engineers; Luncheon Meeting, Engineers Club, New York, N. Y.

Dec. 6-9. American Institute of Chemical Engineers; Sheraton Palace Hotel, San Francisco, California.

Jan. 6. American Institute of Consulting Engineers; Luncheon Meeting, Engineers Club, New York, N. Y.

Jan. 23-26. Consulting Engineers Association of California; Annual Meeting, Ojai Valley Inn, San Francisco, California.

Jan. 31-Feb. 5. American Institute of Electrical Engineers; Winter General Meeting, New York, N. Y.

Feb. 1-4. American Society of Heating Refrigerating and Air-Conditioning Engineers; 2nd Southwest Heating & Air-Conditioning Exposition (Memorial Auditorium) and Semi-annual Meeting (Baker and Adolphus Hotels), Dallas, Texas.

Feb. 3. American Institute of Consulting Engineers; Luncheon Meeting, Engineers Club, New York, N. Y.

Feb. 9. Association of Consulting Chemists & Chemical Engineers, Inc.; Luncheon Meeting, Hotel Shelburne, New York, N. Y.

Feb. 18-20. National Society of Professional Engineers; Winter Meeting, Broadview Hotel, Wichita, Kans.

Feb. 21-24. American Institute of Chemical Engineers; National Meeting, Hotel Biltmore, Atlanta, Ga.

March 6-9. American Society of Mechanical Engineers; Gas Turbine Power and Hydraulic Conference, Rice Hotel, Houston, Texas.

March 14-17. American Concrete Institute; 56th Annual Convention and Exhibit, Commodore Hotel, New York, N. Y.

March 15-17. National Association of Corrosion Engineers; 1960 Corrosion Show and Annual Conference, Dallas, Texas.

March 23-26. Electrical Maintenance Engineers Association of Southern California; Electrical Industry Show and Lighting Exposition, Shrine Exposition Hall, Los Angeles, Calif.

April 3-8. Engineers Joint Council and Instrument Society of America; Sixth Nuclear Congress, New York, N.Y.

April 19. Association of Consulting Chemists & Chemical Engineers, Inc.; Dinner Meeting, Hotel Shelburne, New York, N. Y.

April 19-21. Building Research Institute; Spring Conference, Statler Hilton Hotel, New York, N. Y.

April 27-30. Western Air Conditioning Industries Association; 3rd Western Air Conditioning, Heating, & Refrigeration Exhibit & Conference, Shrine Exposition Hall, Los Angeles, Calif.

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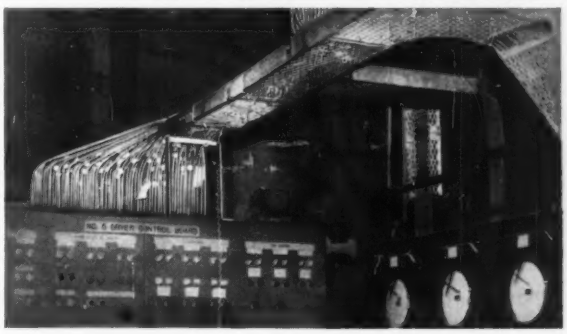

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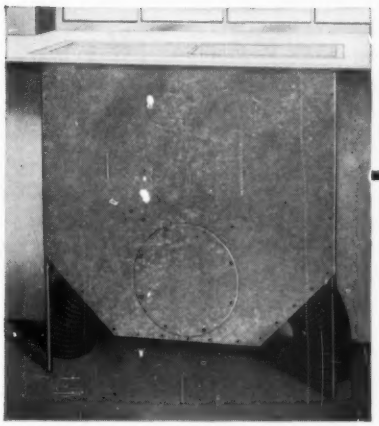
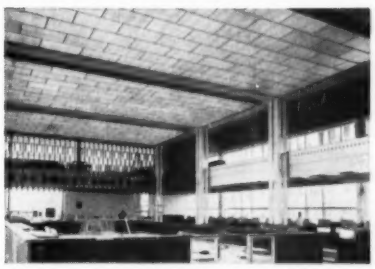
at the new National Bank of Detroit main office . . .



The under-window model, with 45° inlets and top discharge air delivery, produces the same draftless air flow pattern characteristic of all Kno-Draft equipment. The air moves upward along the window and out under the ceiling, effectively conditioning an area approximately 25 feet from the outside wall. Helical spring hot and cold air dampers in each unit ensure proper air mixing . . . and full heating and cooling is achieved because dampers close with less than 2% leakage.



On the main banking floor a grid of aluminum, gold anodized, hexagonal cell lighting diffusers hangs approximately 20" below the ceiling proper, hiding ceiling-mounted lighting channels. Ducts running through a piping space above the ceiling introduce air through Kno-Draft adjustable ceiling air diffusers, all of which enable easy adjustment of air pattern.

KNO-DRAFT air diffusers and high velocity valve attenuators provide constant comfort conditions

At the beautiful new headquarters of National Bank of Detroit, the combination of precisely engineered Kno-Draft dual duct high velocity valve attenuators and adjustable air diffusers provides a 500,000 sq. ft. interior with constant comfort.

The dual hot and cold high velocity air distribution system includes nearly 300 overhead and more than 700 under-window attenuators. These units accurately mix, proportion, and diffuse the air to the building's various rooms at precisely the desired volume and temperature. Kno-Draft attenuating and air diffusion equipment was selected because it responds most rapidly to changing loads . . . most suitably serves the wide variety of comfort demands of occupants in private offices . . . and sharply reduces operational costs.

The Connor Engineering Corporation is justly proud that Kno-Draft equipment was chosen for this leading Detroit building—an endorsement of Connor experience and performance. Numerous Kno-Draft dual duct diffusion models are available. One of these is engineered for your next building.

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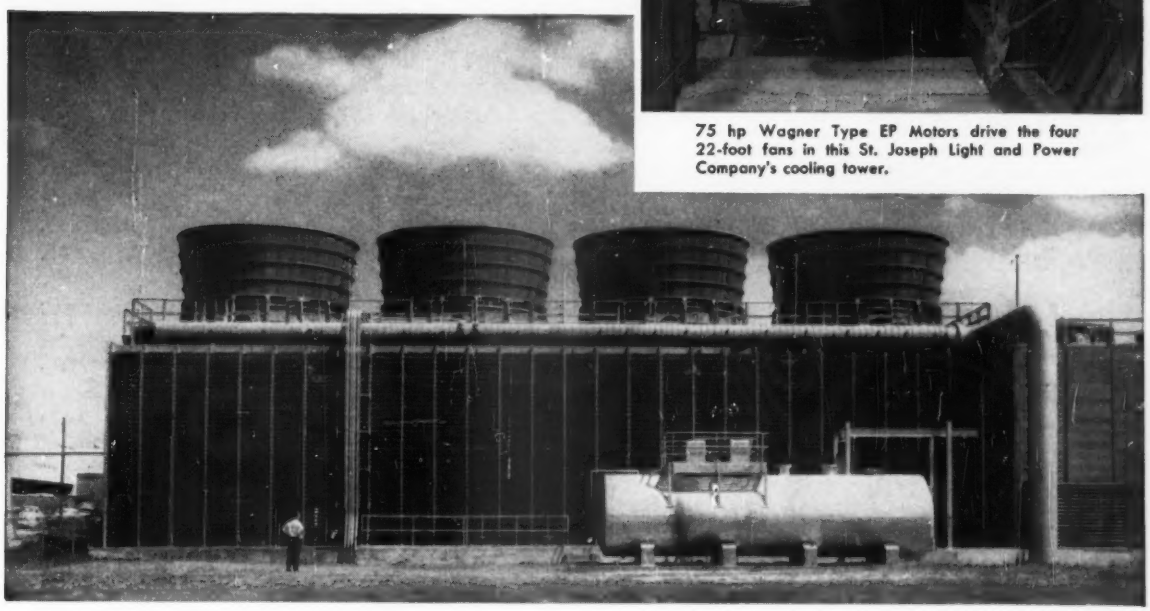
Wagner

ELECTRIC MOTORS . . . THE CHOICE OF LEADERS IN INDUSTRY

St. Joseph Tower for Power COOLS 28,000 GALLONS OF WATER PER MINUTE

75 hp Wagner Type EP Motors drive the four 22-foot fans in this St. Joseph Light and Power Company's cooling tower.



This Marley Double-Flow 4-cell cooling tower, at St. Joseph Light and Power Company, cools water at the rate of 28,000 gallons per minute to get more kilowatts from steam.

Driving 22-foot cooling tower fans is a job for rugged motors—motors that must operate without attention month after month, completely exposed to all kinds of weather and to constant high humidity, the number one cause of motor failure in cooling tower applications.

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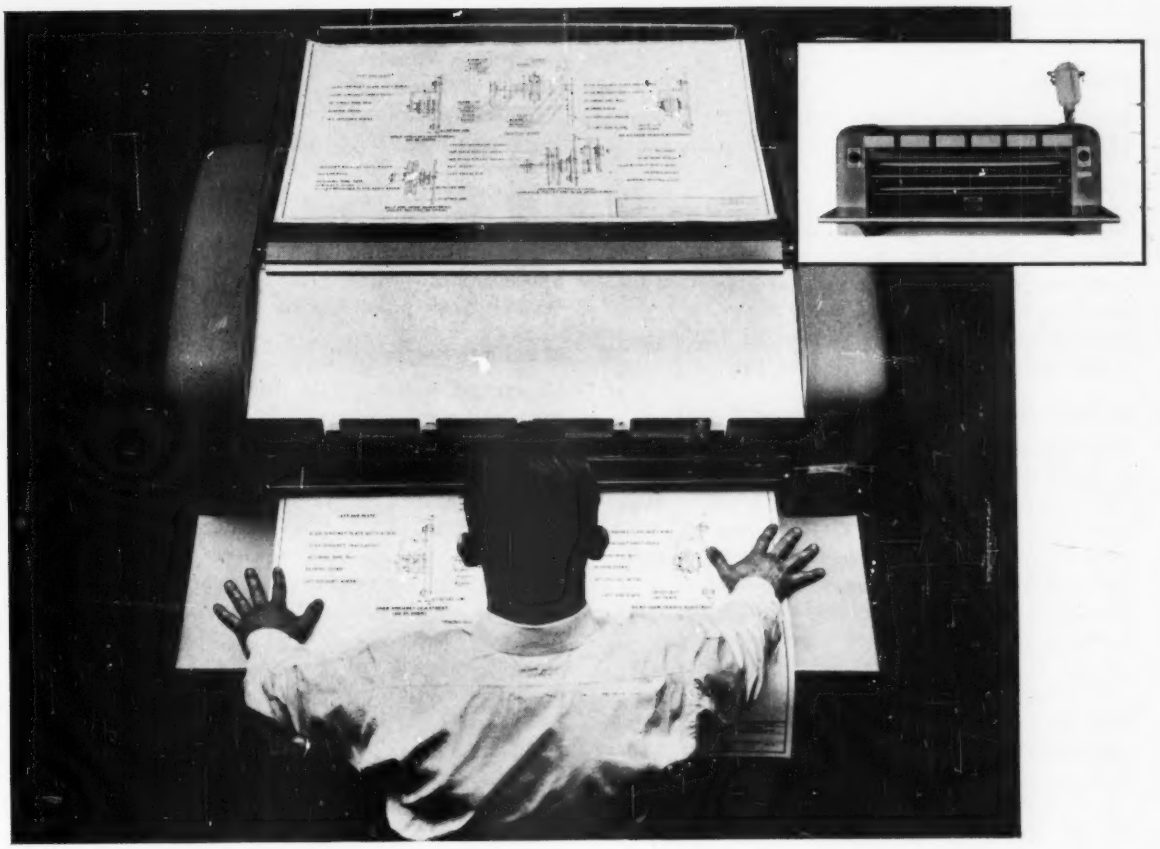

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battle corrosion...last longer

Specify Yoloy (nickel-copper low alloy) steel conduit to handle applications where greater strength, corrosion-resistance, and weldability are required.

Yoloy Conduit should be specified for electrical installations where corrosion is expected to be more severe than normal. Research has proved Yoloy resists corrosion 4 times longer than carbon steel in marine and industrial atmospheres.

Yoloy steels have proved highly resistant to corrosion in oil fields, coal mines, railroad cars, motor trucks and highway construction equipment for over a quarter-century. Long-time tests and actual installations have proved that Yoloy pipe lowers costs when used for salt water lines, oil wells, industrial installations and corrosive soils.

Corrosion studies conducted for 14 years in 13 different soils show that Yoloy has 19% less pitting and 36% less weight loss than carbon steel—and 10% less pitting and 23% less weight loss than wrought iron. This proved corrosion resistance greatly lengthens the life of coatings—galvanized or enameled—on Yoloy Conduit.

Check with your Youngstown Representative and get the complete story on how Yoloy Conduit and E.M.T. can easily meet your most exacting job specifications.

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Send for free technical bulletin on Youngstown Yoloy Conduit and E.M.T.

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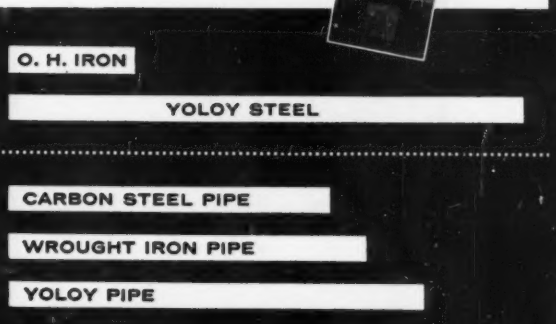
Atmospheric corrosion tests held off the coast of New Jersey revealed Yoloy steel will last four times longer than open-hearth iron.

Youngstown

Expected life increase of Yoloy steel over carbon and wrought iron in corrosive soils. Studies were conducted over a 14-year period in 13 different soils.



Amvit VITRIFIED CLAY LINER PLATES

protect concrete structures from disintegration

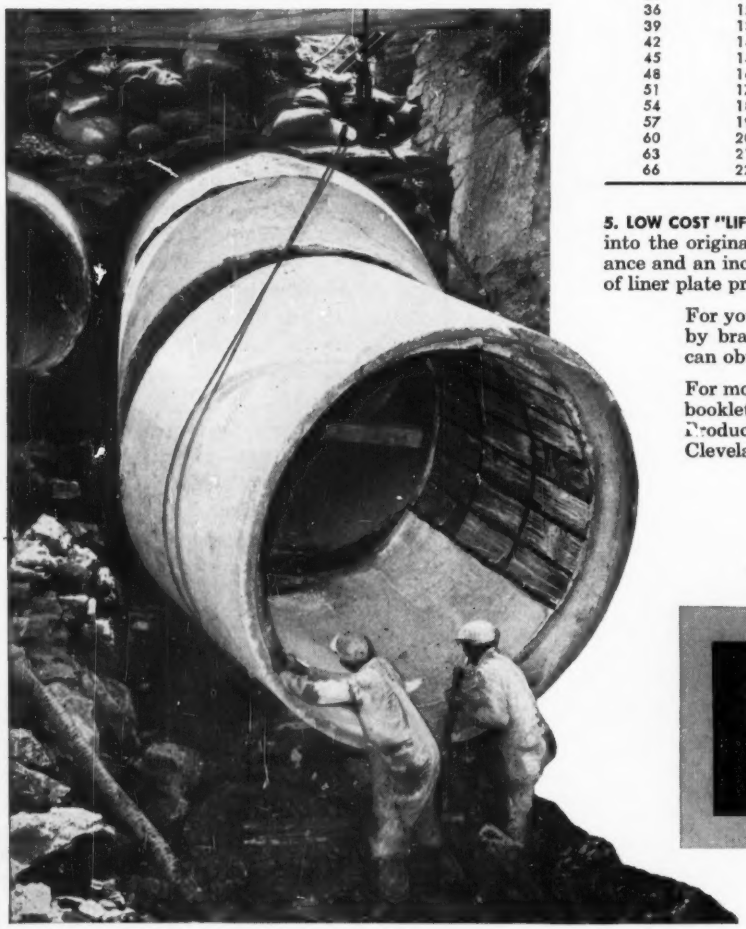
CLAY LINER PLATES ARE UNAFFECTED BY EROSION, ABRASION OR CORROSIVE ACIDS OR GASES

For complete protection of concrete pipe sewers, industrial sewers, acid vats, sewage treatment tanks, neutralizing baths, culverts, retaining walls, and bridges use Amvit clay liner plates for these five big reasons:

1. RESISTS ACID ATTACK — Amvit Liner plates are specially manufactured to meet all application requirements which entail resistance to acids, alkalies, and chemical reaction. They are made of the same high grade clays that go into famous Amvit sewer pipe. They are formed, dried, and vitrified to obtain clay pipe density and hardness.

2. PREVENTS ABRASION — Amvit Liner plates are not affected by the wearing action of sand, rocks, gravel, or other solids often encountered in streams and rivers. They protect all surfaces against corrosion and abrasion.

3. EASY INSTALLATION — Amvit Clay Liner Plates, hardened, glazed, and durable, permanently bond and lock to masonry and concrete work. They are easily installed on concrete forms and are sized according to standardized specifications for uniform spacing.



4. SIZES FOR EVERY JOB — To meet the applications of liner plates in industry, sewerage, and drainage, they are manufactured flat or curved, in 24-inch lengths, 9 inches wide. Lengths under 24 inches for special applications are available on request.

STANDARDS FOR CURVED LINER PLATES

Diameter Sewer	Pieces Required For Circle	Radius	Diameter Sewer	Pieces Required For Circle	Radius
Inches	Number	Inches	Inches	Number	Inches
24	8	12	69	23	33
27	9	13½	72	24	33
30	10	16½	78	26	45
33	11	16½	84	28	45
36	12	18	90	30	45
39	13	21	96	32	45
42	14	21	102	34	45
45	15	21	108	36	60
48	16	24	114	38	60
51	17	26¼	120	40	60
54	18	26¼	126	42	60
57	19	26¼	132	44	60
60	20	33	138	46	60
63	21	33	144	48	72
66	22	33			

5. LOW COST "LIFE INSURANCE" — Building Amvit Liner Plates into the original structure assures a reduction in maintenance and an increase in life expectancy far beyond the cost of liner plate protection.

For your next job, specify *Amvit Clay Liner Plates* by brand. Your local concrete pipe manufacturer can obtain them on short notice.

For more information, write or call for our detailed booklet on Amvit Liner Plates. American Vitrified Products Company, National City Bank Building, Cleveland, Ohio, or our office nearest you.

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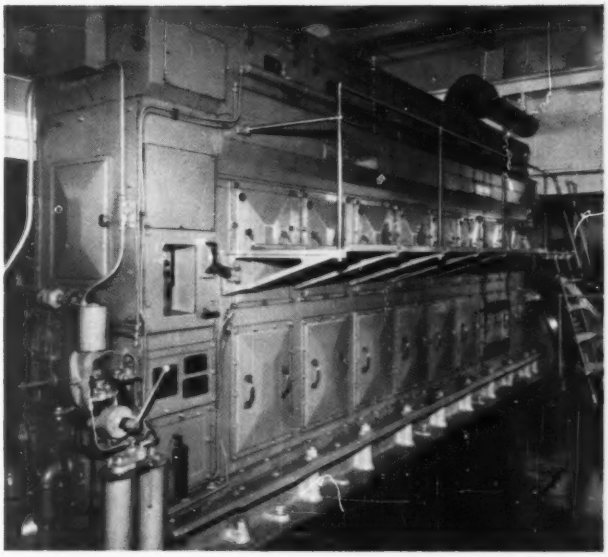
NATIONAL CITY BANK BUILDING

CLEVELAND, OHIO

over 15 KWH per gallon



For the past three years, Consumers Public Service Company of Brookfield, Mo., has achieved remarkable fuel economy with a White Superior Model 80-SX-8 engine-generator package installed at Princeton. The Superior is rated 1440 HP at 360 RPM and drives a generator of 1000 KW capacity. This dependable combination produces over 15 KWH of electricity per gallon of fuel oil, which is 15-25% more power per gallon than comparable engine-generators commonly produce!

Superior's highly developed open chamber combustion system and a competitively-aimed series of exclusive design developments and refinements account for this thrifty performance. Moreover, the high KWH/gallon will remain consistent, because Superior is a rugged, heavy-duty, low-speed engine. It will not eventually "loosen up"—like lightweight, high-speed engines often do—causing a gradual drop in power output per gallon. Superior's economical operation goes far beyond fuel savings, too. Extreme design simplicity eliminates high mortality parts . . . means fewer replacement parts required, reducing maintenance and repair to a minimum.

Model 60 and 80 Stationary Diesels, six or eight cylinder, can be furnished as diesel, dual-fuel or gas engines. They are one segment of a complete line of Superior engines ranging from 190 to 2150 HP, or 150 to 1500 KW. White can custom-engineer a Superior to your exact requirements and apply its extensive experience with automatic, unattended and remote control operations to your problem!

** Superior 80-SX-8 Diesel at Princeton, Missouri, produces 15-25% more power per gallon fuel oil than comparable engine-generators!*

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White Diesel

WHITE DIESEL ENGINE DIVISION
THE WHITE MOTOR COMPANY
Plant and General Offices: Springfield, Ohio

ARE YOU AN ENGINE EXPERT?

An interview with William M. Kauffmann, Chief Engineer of the Engine Division, Worthington Corporation An engine is only as good as the design philosophy behind it. In this short interview, Mr. Kauffmann answers some of the questions most frequently asked him. If you would like to have more complete information about the Worthington line of engines and engine compressors, won't you write to Worthington Corporation, Section 43-6, Harrison, N. J. In Canada: Worthington (Canada) Ltd., Brantford, Ontario.

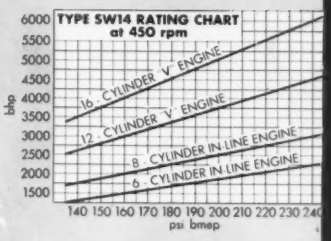
WORTHINGTON

Q. FOR CONTINUOUS-SERVICE HEAVY

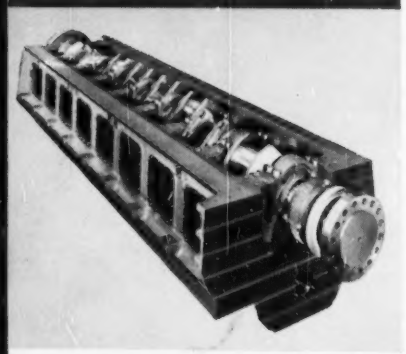
A. Our belief is engines can operate safely today at speeds in the neighborhood of 500 rpm. Shafts can be designed free of critical vibrations through all speed ranges. Of course, other advantages obtained from higher speeds are smaller and less costly generators, less required floor space.

Q. HAS THE MODERN ENGINE REACHED ITS LIMITS IN BMEP?

A. Certainly not. Our SW14 engine, while presently rated at 169 BMEP, was structurally designed for ratings in excess of 200 BMEP. Current research has shown the wisdom of our thinking since we have actually operated this engine in our Research Department at over 200 BMEP.



Q. ACCESSIBILITY OF ENGINES IN

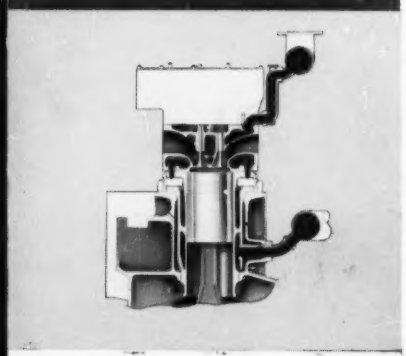


A. Yes, there is. Some engines maintain underslung crankshaft design commonly used on automotive type engines. We agree with the merits of that design on small engines which can be rolled over for access to bearings. In the larger stationary types, we believe the crankshaft should be supported in the base and accessibility to bearings provided through amply large side openings.

Q. WILL MEDIUM SPEED ENGINES BURN RESIDUAL FUEL SUCCESSFULLY?

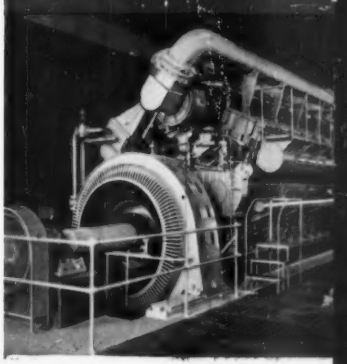
A. Field installations of these units, operating continuously on residual fuels, and reliably supplying power at lowest cost, have demonstrated that this answer is "yes." Contributing to this successful performance is the pre-injection principle patented in Worthington's dual plunger pump. More complete combustion is obtained by introducing a pilot charge ahead of the main charge.

Q. WHAT ARE ADVANTAGES OF INTEGRAL CYLINDER JACKET CONSTRUCTION?



A. The major advantage is simply this: conventional design using wet sleeve liners and sealing rings may be subject to possible leakage of cooling water into the crankcase. The one-piece liner and jacket construction eliminates this problem. In addition, this type of construction provides for more efficient cooling by means of the annular water space. As such, it is particularly adaptable for high temperature cooling.

Q. WHAT TYPES OF FUELS CAN BE UTILIZED?



A. Modern turbocharged engines designed in accordance with Worthington's tri-power principle readily operate as dual fuel, spark ignition or oil diesel—with no change of compression ratio or major engine components. Experience with almost 2-million installed horsepower of all of these combinations in successful operation, provides us with a generous background for future progress in the field of fuel utilization.